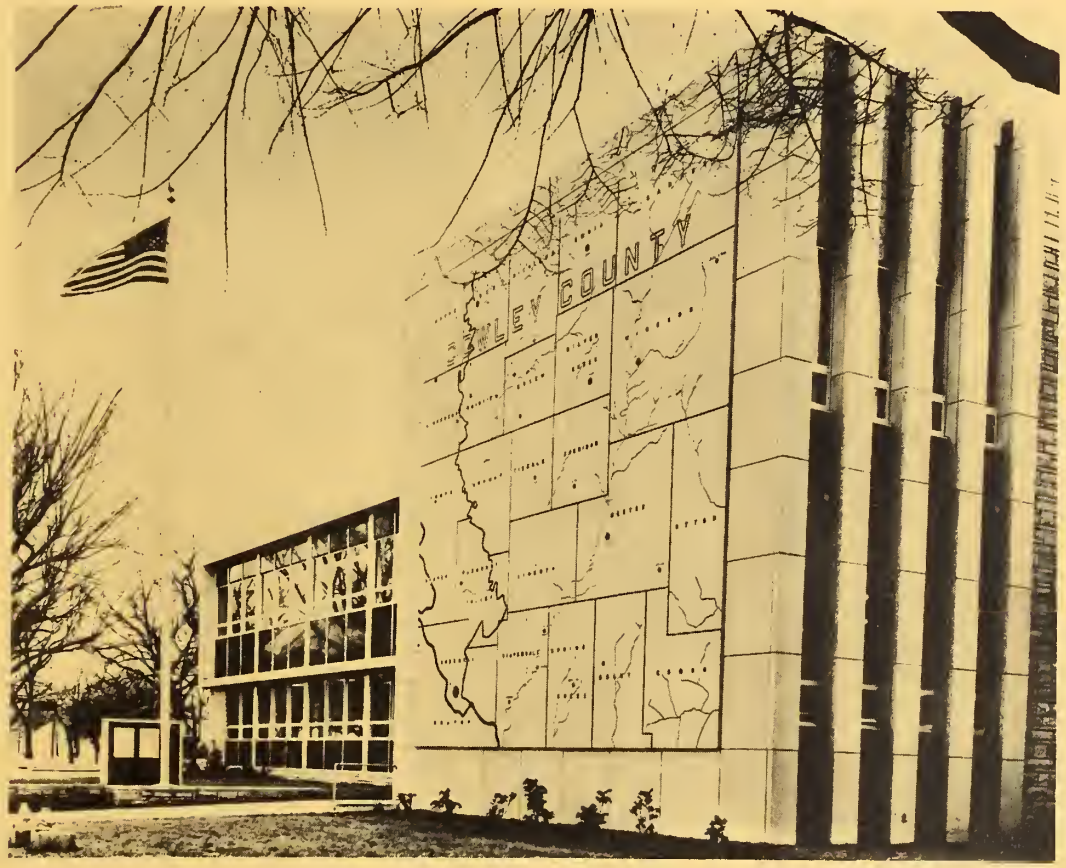
WATERSHED WORK PLAN

TIMBER CREEK WATERSHED

Cowley and Butler Counties, Kansas



MARCH 1965

USDA-SCS-LINCOLN, NEBR 1965

ABOUT THE COVER PICTURE

The Cowley County Courthouse was dedicated on November 17, 1963. A sumptuous county map built of native Silverdale Limestone adorns the front of the new courthouse in Winfield, Kansas. The map reveals Winfield and Timber Creek Watershed in the upper left as a part of the Walnut River Basin.

WATERSHED WORK PLAN

TIMBER CREEK WATERSHED

Cowley and Butler Counties, Kansas

Prepared Under the Authority of the
Watershed Protection and Flood Prevention Act
(Public Law 566, 83rd Congress; 68 Stat. 666), as amended

Prepared by

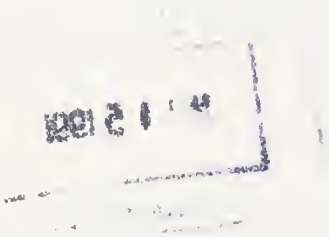
Cowley County Soil Conservation District
Butler County Soil Conservation District
Timber Creek Watershed Joint District No. 38
City of Winfield, Kansas

With Assistance by

U. S. Department of Agriculture
Soil Conservation Service

State of Kansas
State Soil Conservation Committee

March 1965



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SUMMARY OF PLAN

This plan for watershed protection, flood prevention, municipal water supply, and recreational development is sponsored by the Timber Creek Watershed Joint District No. 38, the city of Winfield, and the Cowley and Butler County Soil Conservation Districts. Technical assistance in preparing the watershed work plan was provided by the Soil Conservation Service, United States Department of Agriculture; the Bureau of Sport Fisheries and Wildlife, U. S. Department of Interior; city of Winfield; Kansas State Fish and Game Commission; and Kansas Water Resources Board. The Soil Conservation Service negotiated contracts for engineering services with Van Doren, Hazard, Stallings, and Schnacke, Engineers, Topeka, Kansas, and Wilson and Company, Engineers, Salina, Kansas, using funds provided by the State of Kansas, through the State Soil Conservation Committee. The city of Winfield obtained engineering services of Black and Veatch, Kansas City, Missouri.

Timber Creek Watershed, with a drainage area of 159 square miles or 101,700 acres, is located in the Bluestem Hills of south central Kansas. It is one of seven organized watershed districts in the Walnut River Basin. The seven watershed districts encompass 1,853 square miles of the 1,955 square miles of the Walnut River drainage area. Three watershed projects are authorized for installation and three watershed districts have submitted five applications. The locations of these watersheds and proposed water resource projects of other agencies are shown on the Walnut Basin Map.

Floodwater damage to crops, land, other agricultural property, and roads and bridges are the principal watershed problems. Average annual flood damages in the watershed under existing conditions are estimated to be $216,800. The average annual damage after project installation, including land treatment and structural measures, is estimated to be $63,400. The difference of $153,400 represents an over-all average annual reduction in flood damages of 71 percent.

Works of improvement will include needed land treatment measures together with structural works consisting of 34 floodwater retarding structures, one multiple-purpose structure (municipal and recreational water supply and flood prevention storage), and basic recreational facilities. The structures will have an aggregate capacity of 43,156 acre feet of which 5,757 acre feet are for sediment storage, 9,037 acre feet are for recreation storage, 9,038 acre feet are for municipal

water supply, and 19,324 acre feet are for floodwater detention storage. This system will regulate runoff from a drainage area of 99.92 square miles or 63 percent of the watershed area, provide a water supply to the city of Winfield which has a population of 11,117 and provide recreation for the surrounding territory.

Works of improvement of this plan will directly benefit many people. An estimated 1,200 people living within and 250 people living below the watershed will be directly benefited by watershed protection and flood damage reduction. 7,698 acres of flood plain within the watershed and 9,680 acres of flood plain on the Walnut River lying below the mouth of Timber Creek will be benefited by flood prevention. 11,117 people in Winfield will be benefited by flood protection and an adequate water supply. Several hundred thousand people living around the watershed will be benefited through increased recreation opportunities.

A period of five years is proposed for installing the needed works of improvement at an estimated total cost of $5,208,500. $3,489,300 will be Public Law 566 funds and $1,719,200 will be from other sources.

The cost of the land treatment measures for watershed protection is estimated at $372,500. The share from P.L. 566 funds, consisting entirely of technical assistance is $80,800. The share from other funds is estimated at $291,700. Cost sharing and technical assistance available under other programs will be utilized in applying these measures.

Land treatment applied to date has cost $1,177,200. This has been applied by local people through going programs.

The total cost of all structural measures is $4,836,000 of which $3,408,500 will be borne by P.L. 566 funds and $1,427,500 by local interests.

The city of Winfield will need to build a pipeline and water treatment plant to utilize the water supply feature of this plan. This non-project cost is estimated to be $2,120.000.

Total average annual benefits of the project are $426,400 of which $12,500 are attributed to land treatment measures and $413,900 result from structural measures. A flood damage reduction of 71 percent by works of improvement will result in benefits of $153,400 within the watershed. Benefits accruing from changed land use are $10,400 and from more intensive use are $12,000. The multiple-purpose development will provide $43,800 benefits from a municipal water supply and $146,200 from recreation. Benefits of $38,800 accrue to the project from the flood plain of 9,680 acres lying below the watershed boundary. Secondary benefits of $21,800 will be realized from the project. Additional recreation benefits will be realized from the project but were not monetarily used for justification of this plan.

The ratio of the total average annual benefits from structural measures, $413,900, to the average annual costs, $180,500, is 2.3 to 1.0.

Timber Creek Watershed Joint District will provide land easements and right-of-way and will contract for construction of the single purpose flood prevention structural measures. The city of Winfield will obtain land rights and will contract for construction of the multiple-purpose structure and associated recreational development. The method of watershed district financing will be adopted concurrently with the adoption of the general plan.

Land treatment measures will be maintained by landowners and operators of the farms on which measures are installed. This will be accomplished by agreement with the Cowley and Butler County Soil Conservation Districts.

The 34 single purpose floodwater retarding structures will be operated and maintained by the Timber Creek Watershed Joint District at an estimated average annual cost of $6,800. The city of Winfield will operate and maintain the multiple-purpose structure at an estimated average annual cost of $3,800 and operate, maintain, and replace basic recreational facilities at an estimated average annual cost of $11,500.

DESCRIPTION OF THE WATERSHED

Physical Data

The Timber Creek Watershed lies in the Bluestem Hills area of south central Kansas. The watershed district boundary includes an area of 101,700 acres. About 97,600 acres are in Cowley County and 4,100 acres are in Butler County. The area is about 28 miles long and averages about 12 miles in width.

Timber Creek begins in Butler County about 10 miles northeast of Atlanta, Kansas, flows southwest, and discharges into the Walnut River at the north edge of Winfield, Kansas.

Elevations range from 1,660 feet in the upper end of the watershed to 1,100 feet at the lower end, giving a total fall of 560 feet. 330 feet of fall occurs in the top 10 miles, with 230 feet distributed in the lower 18 miles.

Timber Creek lies in the Flint Hills Upland Physiographic Province. The upper third is gently rolling with shallow valleys cut in cherty limestone. The lower subwatersheds are more rolling, and the streams are deeply incised in thick limestone beds.

The upland soils are chiefly silty clay loam with some claypan. Shallow and gravelly limestone soils occur in the vicinity of rock outcrops. The flood plain soils are predominately silt loams of the Arvonia and Coffey soil series. These are very dark soils with friable or moderately friable silty to clayey subsoils.

Land use in the watershed includes approximately 63 percent native pastureland, 31 percent cropland, 2 percent woodland, and 4 percent miscellaneous. Native vegetation consists of tall grasses and is generally in excellent condition. Timber is located primarily in the bottomlands along the entire length of Timber Creek and its tributaries.

Average annual precipitation for Winfield at the lower end of the watershed is 32.01 inches. Annual precipitation amounts have varied from 19.61 inches in 1956 to 50.20 inches in 1961. Normally, about 70 percent of the precipitation falls during the growing season, April to October. The most intense flood-producing storms occur during the summer months. The highest temperature recorded at Winfield is 118 degrees and the lowest temperature recorded is 27 degrees below zero. The average date of the last killing frost is April 15 and the first killing frost is October 20. The average length of growing season is 188 days.

Economic Data

Land in the watershed is divided among approximately 360 owners. There are 210 farms and ranches in the watershed. The average size of an operating unit is 480 acres.

The rangeland is valued at $80 per acre. Cropland is valued at $105 per upland acre and $200 per flood plain acre.

A majority of the farmers specialize in beef production, utilizing native pasture which covers 63 percent of the watershed area. Winter feeding of cattle and cash crop production are major enterprises in the lower reaches of the watershed where less pastureland is available. Wheat, feed grains, and alfalfa are the principal cultivated crops. Land use in the watershed is as follows:

Land Use	Watershed Total	Flood Plain	
		Without Project	With Project
Cropland	31,500	7,040	6,620
Pasture	64,400	83	78
Woodland	1,800	745	701
Miscellaneous	4,000	414	883
Total	101,700	8,282	8,282

The economy of the area depends to a great extent upon feed grain and alfalfa produced on the flood plain. Farmers, therefore, try to keep these lands in crop production despite frequent and damaging floods. The 7,040 acres of flood plain cropland represents about 22 percent of the cropland in the watershed. Small grains, alfalfa, sorghums, corn, and barley are the principal crops grown on the flood plain.

The system of roads shown on the project map provides access to all parts of the watershed. The road system is considered adequate except when interrupted by high water or flood damage.

Atlanta, with a population of 263, Wilmot, with a population of approximately 30, Floral, with a population of approximately 12, and New Salem with a population of approximately 50, are towns lying within the watershed boundary. Winfield with a population of 11,117 is located at the outlet end of the watershed. Some of the population centers within 30 miles of the watershed are: Wichita - 254,698; Augusta - 6,434; El Dorado - 12,523; Howard - 1,017; Arkansas City - 14,262; and Wellington - 8,809. These and other nearby towns provide adequate market facilities.

Winfield is the county seat of Cowley County. It is a thriving city with its economy based on agriculture, manufacturing, wholesale and retail sales and mineral industries. Southwestern College (Methodist), St. Johns College (Lutheran), and the State Training School for children are located at Winfield. Population of Winfield is expected to increase. Population projections developed by Black and Veatch Consulting Engineers, show:

Year	Estimated Population
1970	12,400
1980	13,600
1990	14,900
2000	16,100
2020	18,600

The Atchison Topeka and Santa Fe Railroad which runs through the lower end of the watershed serves the towns of New Salem and Winfield. The St. Louis San Francisco Railroad runs through the length of the watershed and serves the towns of Winfield, Floral, Wilmot and Atlanta.

Oil and gas production plays an important role in the area's economy. Pipelines necessary for the collection and distribution of these products are much in evidence. Pumping and storage facilities are located in the flood plain.

WATERSHED PROBLEMS

Floodwater Damage

Damage resulting from the flooding of flood plain lands and facilities is the principal problem. Timber Creek is noted for its devastating and frequent floods. In 1959 two destructive floods occurred, one of them causing major damage. Two large floods occurred in 1961, one in July and one in September. The September 1961 flood inundated more than 80 percent of the flood plain.

The flood plain covers 8,282 acres and includes 7,040 acres of cropland valued at $200 per acre. Crop damage due to flooding averages $123,000 annually and accounts for 57 percent of the total flood damage. Flooding is usually of short duration with high velocity flows the major cause of flood damage.

Flooding causes damage to buildings, fences, and machinery. Damage to fences is extremely high, many miles being destroyed or damaged even by minor floods. Most buildings have been moved out of the flood plain because of the frequency of flooding; however, such installations as cattle and hog pens, feed bunks, and stock tanks are frequently damaged. Considerable expense is incurred for clean up of debris after flooding. Agricultural damage of this type averages about $25,200 annually.

Floodwater damage to roads, bridges, and railroads is extensive, amounting to $36,000 on an average annual basis. Flood flows wash away road surfacing, scour road shoulders, silt in roadside ditches, and damage bridges. County and township road budgets are not usually sufficient to make immediate replacements and repairs following a flood. Such costs and needed work are spread over a number of years allowing these essential facilities to remain in a subnormal condition.

Small frequent floods, localized in character, cause considerable damage and inconvenience to farmers in the area of their occurrence. Major floods such as those experienced in 1959 and 1961 affect everyone in the area due to damage to roads, bridges, transportation, utilities, and loss of business to those serving the agricultural community. Such indirect losses under present conditions are estimated to average $20,700 annually.

Flood damages to oil field installations are relatively minor and have not been evaluated for this plan.

Sediment Damage

Damage from sediment deposition on flood plain land is not a serious problem. Sediments are mainly silts and clays and have only slight

detrimental effects on flood plain lands. Some localized gravel deposits cause minor damage. Channel agradation is not a problem.

Sediment deposition in road ditches and ponds is a problem below untreated upland cropland fields.

Erosion Damage

Land damage caused by erosion on the flood plain from flood flows is severe. Large areas of the flood plain are damaged by sheet scour. Very severe damage is caused on smaller areas by the cutting of deep scour channels. Flooding has caused scour damage on about 11 percent of the flood plain. This has reduced the productive capacity of the damaged areas to an extent ranging from 13 to 41 percent. Average annual erosion damage to the flood plain under present conditions amounts to $11,900.

Upland erosion on sloping cropland constitutes a serious problem. Conservation measures have been effective in controlling this erosion. Land damage is causing depletion of cropland on those areas not having land treatment.

Problems Relating to Water Management

The city of Winfield is obtaining its water supply from wells. Most of the present supply is coming from one Ranney Well. Several of Winfield's wells have been ruined in the past by salt water intrusion. This hazard is threatening existing wells and a new supply must be found. All well fields in the area available for water supply development are subject to the same salt water intrusion hazard. For this reason the city must turn to a surface water supply. This will involve development of the reservoir, pipeline, and treatment plant.

Outdoor recreation facilities are inadequate to serve the area. 510,200 people live within a 50-mile radius of the proposed multiple-purpose site. Based on population projections from the Corps of Engineers survey reports on "Kaw Reservoir" and "Walnut River", this population figure may go to 1,500,000 by the year 2020.

A small number of lakes within a 50-mile radius provide for limited recreational opportunities. These include Lake El Dorado and Lake Bluestem with surface areas of approximately 300 and 800 acres respectively, where limited facilities for boating, picnicking, and camping are provided by the city of El Dorado. A city permit is required for boating, fishing, and camping on the area. Other lakes and surface areas are as follows: Augusta, 135 acres; Howard, 60 acres; Butler County, 124 acres; Cowley County, 84 acres; Wellington, 350 acres, and Sedgwick County, 238 acres. All of the above lakes

provide for some recreational opportunities although lakes under the jurisdication of the Forestry Fish and Game Commission are managed primarily for fishing and hunting.

Major lakes lying just beyond the 50-mile radius include Fall River Reservoir, 2,600 surface acres; Hulah Reservoir (Oklahoma), 3,600 surface acres, and Cheney Reservoir, 9,550 surface acres. The annual visitation during calendar year 1963 for Fall River and Hulah Reservoirs was 620,300 and 402,900 respectively. Impoundment of water in Cheney Reservoir did not begin until 1964, consequently, attendance records are not available.

There is insufficient interest or need to include irrigation or drainage as a project purpose. The soils of the flood plain are not well adapted to irrigation. There is no interest in development of water storage for other agricultural uses.

PROJECTS OF OTHER AGENCIES

The Corps of Engineers, Tulsa District, under authority of the House of Representatives Public Works Committee Resolution, adopted 16 October 1951, has recently developed a "Survey Report on Walnut River, Kansas." The plan of improvement includes El Dorado, Douglass and Towanda Reservoirs, modification of the Winfield levee, and a local protection project on the west branch of the Walnut River at El Dorado. This plan has been coordinated with the Corps of Engineers to insure that the works of improvement are harmonious elements for the development of the water resources of the Walnut River Basin.

BASIS FOR PROJECT FORMULATION

The desire of the local sponsoring organization is to reduce to the greatest degree economically possible, floodwater damage to the land, crops and other valuable properties within the flood plain. This must be accomplished with the least possible encroachment on flood plain land which constitutes the heart of a balanced agriculture in the watershed. Without the crops that are produced on the flood plain, a major cattle feeding enterprise would not be economically practical.

The Watershed District Board of Directors working with the Soil Conservation Service Planning Staff selected the floodwater retarding structure system. The system is made up of physically feasible and economically justified tributary structures formulated to provide the highest degree of flood protection economically sound while still permitting optimum use of flood plain lands. Topography of the watershed provides numerous sites for dam construction. Roads, pipelines, utilities, railroads, farm buildings, etc. were physical and economic factors influencing the selection of structure sites. In formulating the structural system a total of 65 possible sites were considered.

Detailed surveys were made of 38 structures to arrive at the final 35 structure system.

The location of the mainstem multiple-purpose structure was determined primarily by the capability of this site to supply water for the city of Winfield and recreation. This site also provides a high degree of flood protection to the lower reaches of the watershed.

Channel improvement as a method of increasing flood protection would be impractical for this watershed. Enlargement of existing channels, in many cases, would involve excavation into limestone.

WORKS OF IMPROVEMENT TO BE INSTALLED

Land Treatment Measures

The application of land treatment measures is essential to a sound and continuing watershed protection and flood prevention program. This is accomplished by the establishment and maintenance of all soil, water, and plant management practices essential for each land use. The result will be a reduction in runoff rates, erosion damages and sediment yield.

Standard soil surveys will be completed over all the watershed. Farmers and ranchers cooperating with the soil conservation district will develop conservation plans that will achieve proper land use and meet the basic conservation needs of the land. The trend will be to continue the rangeland in that land use with improvement being made in the condition of some ranges. A small amount of cropland will be converted to rangeland and pastureland. All of the land uses, including a substantial proportion of cropland, will be involved in the 1,661 acres converted to sediment and water storage in the reservoirs.

Treatment on the cropland will include conservation cropping systems, grassed waterways, terraces, contour farming and crop residue use, plus feasible fertilizer programs. Technical assistance will be required primarily on the first three practices. This treatment will be essential on the relatively large acreage of cropland on the upland above the floodwater retarding structure sites.

Treatment on the rangeland will include proper use, construction of stockwater ponds, and management practices to achieve proper grazing. A high percent of the rangeland is being properly used. Greatest overuse occurs during drouth years. Most of the needed ponds are constructed.

Most of the areas of woodland do not lend themselves to efficient management and some of the sites do not have the potential for economical wood production. They do have some value for wildlife habitat. No specific treatment is prescribed for such areas in connection with the installation of the project.

The amounts and estimated cost of land treatment to be applied during the project period are shown in table 1. The estimated total cost of planning and installing the land treatment measures is $372,500. Public Law 566 funds will be furnished in the amount of $80,800 to provide technical assistance to accelerate the current program. Technical assistance includes completion of standard soil surveys in the watershed at a cost of $8,550 of which $6,915 is included in the P.L. 566 technical assistance item. The remaining $291,700 for installation of land treatment will be provided from other sources.

Structural Measures

A system of 34 floodwater retarding structures and one multiple-purpose structure will be installed at locations shown on the project map. These are required to supplement land treatment measures in meeting project objectives. Physical data for structures is presented in table 3.

The combined drainage area of the system is 99.92 square miles which comprises 63 percent of the total area of the watershed. Total floodwater detention capacity is 19,324 acre feet and sediment storage capacity is 5,757 acre feet in all structures. Structure No. 29 will provide 9,038 acre feet of municipal water storage and 9,037 acre feet of recreation storage. The aggregate capacity of all 35 structures is 43,156 acre feet for all purposes.

Single purpose floodwater retarding structures will be earth dams with pipe principal spillways and vegetated or rock emergency spillways. Figure 2 on page 56 shows features of a typical structure. Multiple purpose site No. 29 will be an earth and rock fill dam with a reinforced concrete box principal spillway and rock emergency spillway. Figure 3 on page 57 shows features of a typical multiple-purpose structure. Principal spillways will have an opening at or near the lowest streambed elevation in the reservoir controlled by either a valve or bolted plate. An ungated principal spillway opening will be placed at the elevation of the 50-year accumulation of sediment. This opening will have a capacity of approximately 10 c.s.m. An additional uncontrolled opening is planned in most of the structures at the elevation of the five-year detention storage to allow for a higher release of storms over this magnitude. This second uncontrolled stage will have a release rate of approximately 15 c.s.m. to allow a total outflow of approximately 25 c.s.m. Vegetated spillways will be planned to operate less frequently than once in 25 years. They are planned to release runoff exceeding reservoir storage capacity safely past the embankment.

Reservoirs will provide storage for the expected 100-year accumulation of sediment with a storage volume equivalent ranging from 0.84 to 1.60 inches per acre from their drainage areas. They are planned with floodwater detention capacity ranging from 2.71 to 4.70 inches of runoff from their drainage areas.

A multiple-purpose structure, Site No. 29, will be installed to furnish 9,037 acre feet of recreation storage, 9,038 acre feet of municipal water supply in addition to 5,000 acre feet of floodwater detention capacity and 1,925 acre feet of sediment storage capacity. The 1,120 surface acre lake with its adjoining 869 acres of public land will provide great opportunity for outdoor recreation. Basic facilities will be provided to serve the public in their use of the area. These facilities include 34,910' of access roads, 140 picnic tables, 85 grills, 70 refuse can receptacles, 30 camp sites, 16 toilets, 8 wells, 5 boat launching ramps, 13 parking areas, 25 signs, 40 acres of grass seeding, 1,275 trees, 1 swimming beach, 3 showers and latrines, and 2 miles of power lines. The reservoir will be stocked with suitable game fish. Areas for undisturbed fishing will be developed through a reservoir zoning plan. In conjunction with this zoning plan, selected areas of timber will be left standing in bays to serve as fish attractors. Land areas in the headwaters of the reservoir will be developed and managed for public hunting. A summary listing of the basic facilities and their costs are shown on table 2B page 26. The Multiple-Purpose Development Map following page 57 shows the location of these facilities.

The total estimated costs of establishing the structural works of improvement are $4,836,000. Table 2 shows cost distribution for each structure.

EXPLANATION OF INSTALLATION COSTS

Areas needing treatment and estimated costs of land treatment measures are shown in table 1. Estimated total costs of planning and installing land treatment measures are $372,500. Public Law 566 funds will be furnished in the amount of $80,800 to provide technical assistance to accelerate the current program. Funds from other sources will be provided in the amount of $291,700 for installing these measures.

The use of facilities method was used to allocate construction and installation services costs of the multiple-purpose structure. The allocations computed in this manner are flood prevention 24.7 percent, recreation 38.7 percent, and water supply 36.6 percent. The city of Winfield will pay all joint and specific costs of water supply plus 50 percent of the construction cost allocated to recreation. Public Law 566 funds will bear all of the construction and installation service cost for flood prevention, 50 percent of the construction cost and 100 percent of the installation services cost of recreation for the water resource improvement.

Construction costs of basic recreation facilities will be cost shared 50 percent each by Public Law 566 funds and the city. The city will be expected to provide engineering and architectural services from its regular staff, without cost sharing, for installing recreation

facilities. Likewise, Soil Conservation Service personnel may assist, as available with on-site locations, designs, and supervision of construction. Where private architectural and engineering services are required, Federal cost sharing will not exceed 50 percent of the payments made for such services.

The cost of land, easements and rights-of-way for the water resource improvement and associated recreation area are cost shared in line with the provisions of Public Law 566 as set forth in Watersheds Memorandum SCS-64.

Public Law 566 costs for structural measures for flood prevention include construction cost and installation services cost. Construction cost includes general construction and vegetative establishment work of the character normally performed by contractors. Installation services include engineering, administrative service and overhead costs of programming and supervision.

Engineering services include all direct and related costs of the services of engineers and geologists for surveys, geologic site investigations and soil mechanics, structure design, construction plans and specifications, construction engineering and supervision. Administrative services include assistance rendered to the local contracting organization in preparing invitations to bid and in awarding construction contracts. Overhead costs include administration and program supervision at all levels concerned with the installation of the program.

Engineering service costs were computed as a percent of construction cost where functions are proportional to construction cost. Flat rates were used in computing functions with relatively fixed costs. Administrative services costs were computed at 8 percent of construction cost.

Construction cost estimates in this plan are based on computation of quantities derived from survey data at each site using unit costs for similar work on watershed projects currently under construction with a contingency allowance of 12 percent. At the time of project installation, additional surveys will be needed at the dam sites as a basis for structural design and construction cost estimates. Geologic drilling and soil mechanic tests and analysis will be performed to verify site and foundation conditions. Reservoir storage volumes will be computed from topographic maps made during work plan preparation.

Land, easements, and rights-of-way values for floodwater retarding structures were determined by the Board of Directors of the Timber Creek Watershed Joint District. Cost estimates were based on current land values varying from $80 per acre for rangeland to $105 per acre for upland cropland. It is recognized that such values may not coincide with actual out-of-pocket costs to the local sponsoring organization because some easements and rights-of-way may be obtained by donation.

Land values in connection with the multiple-purpose site were determined by the city council of Winfield.

Contract administration costs of the local contracting organization will include cost of mailing bid invitations, salary, if any, and expenses of the contracting officer in administering construction contracts. Contract administration costs were estimated on the basis of experience of other watershed districts in Kansas which have carried out construction work.

The estimated total P.L. 566 structural cost and other obligations by fiscal years during the project installation period are as follows:

Fiscal Year	P.L. 566 Costs	Other Costs	Total
First	270,200	86,300	356,500
Second	771,400	155,700	927,100
Third	1,304,900	979,300	2,284,200
Fourth	693,300	436,100	1,129,400
Fifth	449,500	61,800	511,300
Total	3,489,300	1,719,200	5,208,500

The cost of applying land treatment measures is based on current costs of applying such measures under going programs.

EFFECTS OF WORKS OF IMPROVEMENT

The flood prevention program will directly benefit 360 landowners within the watershed. The program of land treatment and structural measures will accomplish a 71 percent reduction in total watershed average annual flood damages. The area benefited in each reach is shown in the following table:

Reach	Area Benefited Acres	Reach	Area Benefited Acres
1	1,670	S-1	323
2	686	S-2	96
3	476	N-1	702
4	399	N-2	653
5	772	N-3	232
6	551	N-3A	86
6A	88	N-3B	96
7	568	N-4	103
7A	68		
7B	129	Total	7,698

The program effect on the September 1961 storm is represented by Figure 1, page 55. This aerial view of the flood plain shows part of reaches 1 and 2 from near the Murfin farm upstream to near the Loren Holt farm. The super-imposed lines and cross hatching show flooded area with and without the watershed program. The flooded area shown was reduced from 382 acres to 102 acres (excluding channel) or a reduction of 73 percent. The low degree of structural control on Little Cedar Creek is evident by the increase in remaining area flooded in reach 1 below the Little Cedar Creek and Timber Creek junction. For this same storm works of improvement reduced the total watershed flood plain area flooded by 3,027 acres. An additional 3,487 acres were benefited by a substantial reduction in depth of flooding.

Reduction in the depth and frequency of flooding will substantially reduce crop losses. The reduction in the flood hazard will induce farmers to use more fertilizer, improved crop varieties, and establish soil building rotations. Farmers will be able to perform tillage, planting, and harvesting operations on a timely basis for improved production.

Losses in productivity due to removal of soil by flood plain scour will be substantially reduced. The reduction in flooding will likewise make it possible to restore productivity on previously damaged land at a more rapid rate.

A substantial reduction in costs of maintaining roads and bridges on the flood plain will be realized. The reduction in cost of repairing flood damages will release road and bridge funds for use in improving and modernizing the existing road system.

The watershed project will bring about a land use adjustment. A more complete job of conservation farming on the upland will cause a conversion of some cropland to pasture. A reduction in frequency of flooding on the flood plain will allow 468 acres of land now in brushy pasture and timber to be converted to cropland. 425 acres of flood plain cropland and 1,451 acres of upland cropland will be converted to water storage and recreational use by the system of 34 floodwater retarding structures and 1 multiple-purpose structure.

Facilities necessary for the collection, storage and distribution of oil and gas will benefit from the installed flood prevention measures. The costs necessary to relocate or protect pipelines affected by floodwater retarding structures have been determined by coordination with the appropriate petroleum and pipeline companies. All elements of this project are harmonious with known mineral resources.

Works of improvement will provide important benefits to an area of 9,680 acres below the watershed boundary. These have been jointly evaluated by the Kansas Water Resources Board; Corps of Engineers, Tulsa District; and the Soil Conservation Service. Benefits from the

reduction of flooding to 9,270 acres of agricultural land, 410 acres of urban area, transportation facilities, and public utilities will accrue along the mainstem of the Walnut River from the mouth of Timber Creek to its junction with the Arkansas River.

Secondary benefits stemming from the project are realized from transporting, processing and marketing agricultural commodities produced as a result of reducing crop losses by flooding. Secondary benefits induced by the project include the increased net return to suppliers of farm equipment and materials required to achieve the increased agricultural production made possible by the project, the increased net return to local retailers and wholesalers from consumer expenditures by the farm family resulting from increased farm income, and any other increase in net returns resulting from costs directly associated with marketing or using project goods or services. Secondary benefits from a national viewpoint were not considered pertinent to the economic evaluation.

The city of Winfield will obtain an adequate supply of high quality water from the multiple-purpose development Site No. 29. This will replace their present supply from wells which is in danger of inadequacy from salt water intrusion. A surface water supply for their use in this site was recommended by their engineering consultant and the Kansas Water Resources Board. The following is an excerpt from a letter to the city of Winfield from their consulting engineers, Black and Veatch, Kansas City, Missouri dated November 9, 1964:

> "We have carefully reviewed the data supplied by the Soil Conservation Service and, in addition, have conferred with staff members of the Kansas Water Resources Board and the Kansas State Board of Health. After review and analysis of all project information in the light of our own experience in water resource and public water supply developments, we conclude as follows:
>
> 1. The proposed Timber Creek Reservoir will meet the City's water supply needs until approximately the year 2000. In arriving at this estimate, which we consider conservative, we have made reasonable allowances for population growth and increase in per-capita water use.
>
> 2. The quality of the water derived from the Timber Creek Reservoir will be suitable, after conventional water treatment, for all municipal use. We anticipate that the mineral quality of the water impounded in Timber Creek Reservoir will be substantially superior to the ground-water supplies now available to the City.

3. Based on our study of the dam location and related geological and soil mechanics data, we conclude that if the dam is properly constructed, the reservoir will hold water without undue losses."

Benefits to a large land area and sector of the general public will accrue to the recreation feature of multiple purpose Site No. 29. The total population within a fifty-mile radius of the project slightly exceeds 500,000. The number of people per surface acre of water in this area is about 250 to 1 as compared with the State average of 31 to 1.

It is estimated that 100,000 people will visit this area for recreation annually. An average weekend day could expect 2,500 in attendance. This development will supply the facilities necessary for picnicking, swimming, sightseeing, outdoor games, fishing, boating, hunting and camping for this number of people. This area is potentially able to accommodate increases in visitor use above that originally planned. Land area purchased through cost sharing can provide for double or triple the original estimated attendance. Additional facilities would need to be provided but this can be done to meet the demand. Public access is adequately provided.

Incidental recreation benefits in Timber Creek Watershed will accrue to the public. There are 34 single purpose floodwater retarding reservoirs with sediment pools ranging in size from 9 to 37 acres. These pools will afford recreational facilities of fishing, boating, and hunting. In addition, camping facilities will be available in the area surrounding this water. These benefits were not evaluated monetarily or used for project justification.

A general benefit to the fish resources of the area is expected. Stream fishing will be improved as a result of more stabilized flows below the floodwater retarding structures. Permanent storage pools in the floodwater retarding reservoirs will increase the fishing opportunities in the watershed. Increased water area of some 1,661 acres widely distributed over the watershed will benefit waterfowl by providing resting areas and some winter habitat. Upland game birds will be displaced from the permanent pool area of the detention structures, but terrestrial species will benefit from flood reduction in the protected bottomlands where not intensively cultivated. Landowners and operators will be encouraged to include wildlife conserving practices along with other conservation measures on their lands.

PROJECT BENEFITS

Benefits of $214,600 accrue to flood prevention. Of these $12,500 accrue to land treatment measures and $202,100 are attributable to floodwater retarding structures. Individual items of benefit are shown in tables 5 and 6.

Benefits from reduction in floodwater damage to crops average $88,200 annually and account for 50 percent of the flood prevention benefits within the watershed. Reduction of the flood hazard makes possible benefits from more intensive use of land through improved crop rotations and use of fertilizer. More intensive use benefits will average $12,000 annually. Benefits from changed land use will amount to $10,400 annually within the watershed.

Benefits from reducing damages to flood plain land by scour will average $6,200 annually. Benefits from reduction in floodwater damage to roads, bridges, and railroads amount to $26,900 and similar benefits to other agricultural property such as stored feed, fences, buildings, and other farm improvements are $17,500 on an average annual basis.

Indirect average annual benefits realized by less interrupted travel, halting or delays in mail, school busses, and milk routes amount to $14,600 within the watershed.

The value of local secondary benefits stemming from the project will be $18,900. Secondary benefits induced by the project will amount to $2,900 giving a secondary benefit total of $21,800 annually.

Flood prevention benefits outside the watershed will accrue from works of improvement including the three proposed Corps reservoirs, three authorized watershed projects and six proposed watershed projects. The portion of these benefits assigned to Timber Creek works of improvement averages $38,800 annually. These benefits stem in a large measure from reduction in floodwater damage to crops on the flood plain and to the city of Winfield.

Average annual benefits of $43,800 are attributed to the municipal water supply in multiple purpose Site No. 29. These benefits were based on the minimum cost of developing adequate alternate supply. Water supply from this site will be developed as the main source of water supply for the city of Winfield.

The multiple-purpose development will produce annual benefits to recreation of $146,200. These will accrue to hunting, fishing, picnicking, swimming, sightseeing, boating, and camping.

In addition to the monetary benefits, there are other substantial intangible values which will accrue from the project, such as better living conditions, a sense of economic security and abatement of the fear of flood damage.

COMPARISON OF BENEFITS AND COSTS

The average annual cost of structural measures, including installation, operation and maintenance is $180,500. When the project is completely installed, the structural measures are expected to produce average annual benefits of $413,900. The benefit-cost ratio without the inclusion of local secondary benefits is 2.2 to 1. An additional benefit-cost ratio computed by combining local secondary benefits with all other benefits (see table 6) is 2.3 to 1.

PROJECT INSTALLATION

The works of improvement will be installed in a 5-year period. Federal assistance for carrying out the works of improvement on non-Federal land as described in this work plan will be provided under authority of the Watershed Protection and Flood Prevention Act (Public Law 566, 83rd Congress, 68 Stat. 666), as amended.

Land Treatment Measures

Land treatment measures will be established on the land by the farm owners and operators in cooperation with the Cowley and Butler Soil Conservation Districts. The cost of applying these measures will be borne by the owners and operators of the land. The Soil Conservation Service will provide technical assistance in planning and establishing land treatment measures. Technical assistance to the soil conservation districts will be accelerated to assure application of the planned measures within the 5-year installation period of the project.

The Extension Service will assist in carrying out the educational phase of the program by preparation of general information in cooperation with the governing bodies of the Soil Conservation and Watershed District Boards. The Farmer's Home Administration soil and water loan program will be available to eligible farmers in the area. The County Agricultural Stabilization and Conservation Committees will cooperate with the governing bodies of the soil conservation districts to accelerate Agricultural Conservation Program financial assistance for those practices which will accomplish the conservation objectives. The supervisors of the Cowley and Butler County Soil Conservation Districts will encourage landowners and operators within the Timber Creek Watershed to install soil and water conservation measures on their farms.

Structural Measures

The Timber Creek Watershed Joint District will contract for the construction of the 34 floodwater retarding structures. These will be installed through construction contracts awarded on the basis of competitive bidding. Separate contracts will be awarded for general

construction and for vegetative establishment. The watershed district will appoint a contracting officer and will bear the cost of contract administration.

The watershed district will obtain all land rights, easements, and rights-of-way needed for installation of the 34 floodwater retarding structures. They have the power of eminent domain to obtain land rights for public improvements and have agreed to use such authority when needed. Arrangements will be made with the county commissioners for abandonment, relocation, or modification of any roads requiring such action. The watershed district will likewise arrange for any relocation or modification of pipelines, communication lines, or other public utilities which are necessary in connection with the project installation.

The city of Winfield will contract for the construction of the multiple-purpose structure and basic recreation facilities. Construction contracts will be awarded on the basis of competitive bidding. The city will bear the cost of the contracting officer and contract administration.

The city of Winfield will obtain either by negotiation or condemnation all land, easements and rights-of-way needed for the multiple-purpose structure and the minimum basic facilities. They have all necessary powers to obtain these land, easements and rights-of-way. They will arrange with the county commissioners for abandonment, relocation, or modification of any roads requiring such action. The cost of land acquired in fee title and road and pipeline relocations and modifications allocated to the recreation feature of the structure will be shared by P.L. 566 funds. Cost sharing is shown in table 2A and table C, page 54.

After Federal assistance is authorized for installation of the project, the Soil Conservation Service will furnish engineering services to prepare construction plans and specifications for the 34 floodwater retarding structures and will furnish their share of the funds for an A&E contract for the design of the multiple-purpose structure. Construction can be started when all necessary land easements and rights-of-way have been obtained, P.L. 566 funds are available, and local sponsoring organizations have complied with State laws relating to approval of construction plans.

FINANCING PROJECT INSTALLATION

The Timber Creek Watershed Joint District was created and validated in accordance with the Kansas Watershed District Act as amended. The watershed district has all the necessary authority and power to finance and to carry out watershed improvements. These powers include the right to accept contributions, levy taxes, make assessments against land specially benefited, issue bonds, and exercise the right of eminent domain.

The expenses of organizing the district have been paid and current general expenses are being met by an annual ad valorem tax levy.

The City of Winfield expects to finance the multiple-purpose development through a combination of money on hand and revenue bonds. They expect to pay for in part and operate and maintain the recreation development through user fees and concessions.

The watershed district has been furnished land rights work maps for all structural measures as a basis for contacting landowners and appraising costs to the district. The Board of Directors believe, based on contacts with landowners, that most of the needed land easements and rights-of-way will be donated. Land rights which must be purchased will be financed by a general tax levy.

Funds for construction costs will be provided to the local sponsoring organizations as grants-in-aid through project agreements for construction executed with the Soil Conservation Service. A project agreement will be executed for each structural measure or group of structural measures to be included in a construction contract.

Federal technical assistance, installation services, and grants-in-aid for construction are contingent upon appropriation of funds for these purposes.

Soil Conservation Districts will seek such allocation of Agricultural Conservation Program funds as are needed to cost share on land treatment measures to meet project objectives within the watershed. Technical assistance available from the Soil Conservation Service in its program of assistance to soil conservation districts will continue at current rates.

PROVISIONS FOR OPERATION AND MAINTENANCE

Land Treatment Measures

The land treatment measures will be maintained by the landowners and operators of the farms on which the measures are installed under agreements with the soil conservation districts serving the area. Representatives of the soil conservation districts will make periodic inspections of the land treatment measures to determine maintenance needs and will encourage landowners to perform needed maintenance.

Structural Measures

An agreement providing for operation and maintenance of the structural measures will be executed by the local sponsoring organizations before Federal construction funds are made available.

The 34 floodwater retarding structures will be operated and maintained by the Timber Creek Watershed Joint District, and the multiple-purpose structure and the recreational facilities will be operated and maintained by the city of Winfield. All structural measures will be inspected by representatives of the local sponsoring organizations and the Soil Conservation Service at least annually and after each heavy runoff producing storm. Items of inspection will include but not be limited to the conditions of the principal spillway and its appurtenances, the emergency spillway, the earth fill, the vegetative cover of the earth fill and emergency spillway, any fences installed as a part of the structural measures and all recreation facilities. The Timber Creek Watershed Joint District and the city of Winfield will maintain a record of maintenance inspections.

Recreation facilities will need to be replaced periodically. Useful life will vary as to the facility and its use. An average replacement period of 20 years has been used to compute replacement costs. The city of Winfield will replace recreation facilities following a schedule based on need.

Maintenance work will be carried out when needed. Kinds of maintenance work that would be expected rather frequently are repairs to fence and recreation facilities, clearing of debris, mowing of dam and spillway, etc. Repairs to major construction items such as the dam and spillway are expected very infrequently.

The estimated average annual operation, maintenance, and replacements costs are $22,100. The necessary maintenance will be accomplished through contributed labor and equipment and/or hired labor and equipment. Funds for accomplishing the maintenance work carried out by the watershed district will be obtained from an annual tax levy within the district. Funds for maintaining and replacement of the recreation facilities will be obtained from a fee for their use.

Provisions will be made for access to inspect the structural system at any time.

TABLE 1 - ESTIMATED PROJECT INSTALLATION COST

Timber Creek Watershed, Kansas

Installation Cost Item	Unit	Number Non-Fed. Land	Estimated Cost (Dollars)[1/]		
			P. L. 566	Other	Total
Land Treatment					
Soil Conservation Service					
Cropland	Ac.	10,600		233,500	233,500
Rangeland	Ac.	8,500		37,900	37,900
Technical Assistance			80,800	20,300	101,100
TOTAL LAND TREATMENT			80,800	291,700	372,500
STRUCTURAL MEASURES					
Construction					
Floodwater Retarding Structures	No.	34	1,837,100		1,837,100
Multiple-Purpose Structure	No.	1	452,200	574,400	1,026,600
Basic Recreation Facilities	No.	1	72,800	72,800	145,600
Subtotal Construction			2,362,100	647,200	3,009,300
Installation Services					
Engineering			540,700	35,200	575,900
Other			159,200	7,800	167,000
Subtotal Installation			699,900	43,000	742,900
Other Costs					
Land, Easements & R/W			346,500	726,100	1,072,600
Administration of Contracts				11,200	11,200
Subtotal Other			346,500	737,300	1,083,800
TOTAL STRUCTURAL MEASURES			3,408,500	1,427,500	4,836,000
TOTAL PROJECT			3,489,300	1,719,200	5,208,500

1/ Price base 1964

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TABLE 1A - STATUS OF WATERSHED WORKS OF IMPROVEMENT

Timber Creek Watershed, Kansas

Measures	Unit	Applied to Date	Total Cost (Dollars) 1/
LAND TREATMENT			
Conservation Cropping System	Acre	26,200	655,000
Range Proper Use	Acre	40,200	4,000
Range Seeding	Acre	973	19,500
Pasture Planting (tame)	Acre	747	14,900
Grass Waterways	Acre	591	102,900
Diversions	Mile	34	14,400
Farm Ponds	No.	204	306,000
Terraces - Gradient	Mi.	267	60,500
Total			1,177,200

1/ Price base 1964

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TABLE 2 - ESTIMATED STRUCTURAL COST DISTRIBUTION
Timber Creek Watershed, Kansas

(Dollars)[1/]

Structure Site No.	Installation Cost - P. L. 566 Funds					Installation Cost - Other Funds						Total Installation Cost
	Construction	Installation Services		Land Easements & R/W	Total P. L. 566	Construction	Installation Services		Adm. of Contracts	Land Easements & R/W	Total Other	
		Engineering	Other				Engineering	Other				
1	62,300	13,800	5,000		81,100				300	23,300[2/]	23,600	104,700
2	66,100	16,000	5,300		87,400				300	9,500[3/]	9,800	97,200
3	48,600	14,000	3,900		66,500				300	2,500	2,800	69,300
4	46,000	13,400	3,600		63,000				300	3,100	3,400	66,400
5	40,900	12,300	3,300		56,500				300	3,400	3,700	60,200
6	42,000	12,600	3,400		58,000				300	2,900	3,200	61,200
7	41,900	12,500	3,400		57,800				300	2,900	3,200	61,000
8	41,700	12,500	3,300		57,500				300	3,700	4,000	61,500
9	43,700	12,900	3,500		60,100				300	2,200	2,500	62,600
10	52,400	15,000	4,200		71,600				300	11,100[4/]	11,400	83,000
11	53,600	14,700	4,300		72,600				300	8,800[5/]	9,100	81,700
12	32,300	10,500	2,600		45,400				300	2,100	2,400	47,800
13	50,800	14,400	4,100		69,300				300	3,200	3,500	72,800
14	44,400	13,100	3,500		61,000				300	4,500[6/]	4,800	65,800
15	53,900	14,800	4,300		73,000				300	3,000	3,300	76,300
16	46,200	13,500	3,700		63,400				300	4,400[7/]	4,700	68,100
17	58,200	15,300	4,700		78,200				300	2,600	2,900	81,100
18	65,800	16,000	5,300		87,100				300	4,700[8/]	5,000	92,100
19	81,000	17,200	6,500		104,700				300	6,300	6,600	111,300
20	82,500	17,300	6,600		106,400				300	10,800	11,100	117,500
21	117,600	21,600	9,400		148,600				300	11,400	11,700	160,300
22	54,900	14,900	4,400		74,200				300	7,300	7,600	81,800
23	42,000	12,600	3,300		57,900				300	4,000	4,300	62,200
24	37,100	11,600	3,000		51,700				300	3,300	3,600	55,300
25	43,100	12,800	3,400		59,300				300	4,100	4,400	63,700
26	65,400	16,000	5,200		86,600				300	5,200	5,500	92,100
27	39,800	12,100	3,200		55,100				300	2,100	2,400	57,500
28	60,200	15,600	4,800		80,600				300	3,100[9/]	3,400	84,000
30	69,800	16,300	5,600		91,700				300	8,300[9/]	8,600	100,300
31	68,600	16,200	5,500		90,300				300	3,000	3,300	93,600
32	43,500	12,900	3,500		59,900				300	4,000	4,300	64,200
33	40,000	12,200	3,200		55,400				300	2,800	3,100	58,500
34	54,000	14,800	4,300		73,100				300	5,700[10/]	6,000	79,100
35	46,800	13,600	3,700		64,100				300	4,700[10/]	5,000	69,100
Subtotal	1,837,100	485,000	147,000		2,469,100				10,200	184,000	194,200	2,663,300
Multiple Purpose Structure Site No. 29	452,200	48,400	10,700	264,900	776,200	574,400	27,900	6,300	1,000	417,600	1,027,200	1,803,400
Basic Recreational Facilities	72,800	7,300	1,500	81,600	163,200	72,800	7,300	1,500		124,500[11/]	206,100	369,300
Subtotal	525,000	55,700	12,200	346,500	939,400	647,200	35,200	7,800	1,000	542,100[12/]	1,233,300	2,172,700
TOTAL	2,362,100	540,700	159,200	346,500	3,408,500	647,200	35,200	7,800	11,200	726,100	1,427,500	4,836,000

1/ Price base 1963
2/ Raise road and replace bridge $16,800
3/ Purchase old buildings $1,000
4/ Raise road $7,038
5/ Raise road $4,164
6/ Raise road $1,000
7/ Pipeline relocation $2,078
8/ Pipeline relocation $1,113
9/ Raise oil well $1,500
10/ Dike around buildings $300 and raise road $780
11/ 146 acres without Federal assistance $32,900
12/ Flowage easements, legal fees, survey costs, and other $33,000

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TABLE 2A - COST ALLOCATION AND COST SHARING SUMMARY

Timber Creek Watershed, Kansas

(Dollars)[1/]

Item	Purpose			Total
	Flood Prevention	Recreation	Municipal Water	
	COST ALLOCATION			
Single Purpose Floodwater Retarding Structures (34 sites)	2,663,300			2,663,300
Multiple Purpose Site No. 29	278,100	1,349,300	545,300	2,172,700
Total	2,941,400	1,349,300	545,300	4,836,000
	COST SHARING			
P.L. 566	2,745,700	662,800		3,408,500
Other	195,700	686,500	545,300	1,427,500
Total	2,941,400	1,349,300	545,300	4,836,000

1/ Price base 1964

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TABLE 2B - ESTIMATED CONSTRUCTION COSTS
Basic Recreational Facilities

Timber Creek Watershed, Kansas
Site 29

Item	Number	Unit Cost	Total Cost
Gravel roads (one way)	5,800 ft.	$1,875/mi.	$ 2,055
(two way)	29,110 ft.	2,500/mi.	13,545
Picnic tables	140	50	7,000
Grills	85	50	4,250
Refuse can receptacles	70	30	2,100
Camping sites	30	275	8,250
Toilets, with concrete vault	10	500	5,000
Wells, 4" casing	5	500	2,500
Boat launching ramps, docks, parking	5		16,500
Picnic shelters (14' x 28')	15	600	9,000
Parking areas (300' x 20')	3,100 ft.	2.00/ft.	6,200
Signs	25		1,550
Grass seeding	40	50	2,000
Trees, including establishment	1,275	10	12,750
Swimming beach (400' x 350' x 6")	1	5,000	5,000
Showers and latrines	3	10,000	30,000
Electric power line	2 mi.	800	1,600
Pit toilets	6	150	900
Parking area (1/4 acre)	2	250	500
Wells and distribution, 12" casing	3	5,000	15,000
			$145,700

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TABLE 3 - STRUCTURE DATA

FLOODWATER RETARDING STRUCTURES
Timber Creek Watershed, Kansas

ITEM	UNIT	STRUCTURE NUMBER 1	2	3
Drainage Area	Sq. Mi.	2.58	3.78	1.10
Storage Capacity				
Sediment	Ac. Ft.	161	180	58
Floodwater	Ac. Ft.	520	762	222
Water Supply	Ac. Ft.			
Total	Ac. Ft.	681	942	280
Between High and Low Stages	Ac. Ft.	395	554	164
Surface Area				
Sediment Pool	Acres	26	29	11
Floodwater Pool	Acres	86	116	38
Water Supply Pool	Acres			
Volume of Fill	Cu. Yds.	82,930	86,310	64,260
Elevation Top of Dam	Feet	1,504.1	1,469.8	1,463.2
Maximum Height of Dam	Feet	26.1	30.2	26.8
Emergency Spillway				
Crest Elevation	Feet	1,499.1	1,464.6	1,458.2
Bottom Width	Feet	40	40	40
Type	--	Rock	Rock	Veg.
Percent Chance of Use	--	4	4	4
Average Curve No. - Cond. II	--	80	80	80
Emergency Spillway Hydrograph				
Time of Concentration	Hrs.	1.50	2.00	1.00
Storm Rainfall (6 hours)	Inches	6.08	6.08	6.08
Storm Runoff	Inches	3.85	3.85	3.85
Velocity of Flow (Vc) 1/	Ft./Sec.	3/	3/	3/
Discharge Rate 1/	c.f.s.	3/	3/	3/
Maximum W. S. Elevation 1/	Feet	3/	3/	3/
Freeboard Hydrograph				
Storm Rainfall (6 hours)	Inches	8.68	8.68	8.68
Storm Runoff	Inches	6.26	6.26	6.26
Velocity of Flow (Vc) 1/	Ft./Sec.	6.0	7.4	5.9
Discharge Rate 1/	c.f.s.	276	512	256
Maximum W. S. Elevation 1/	Feet	1,501.5	1,468.0	1,460.5
Principal Spillway				
Capacity - Low Stage 2/	c.f.s.	25.8	37.8	11.0
Capacity - High Stage 2/	c.f.s.	64.5	94.5	27.5
Capacity Equivalents				
Sediment Volume				
Below Crest of Prin. Splwy.	Inches	.65	.50	.55
Above Crest of Prin. Splwy.	Inches	.52	.39	.43
Total	Inches	1.17	.89	.98
Detention Volume	Inches	3.77	3.77	3.77
Spillway Storage	Inches	4.03	3.13	3.63
Class of Structure	--	a	a	a

1/ Maximum during passage of hydrograph
2/ These are average capacities based on 0.8 times the peak capacity with the maximum head at the crest of the next stage
3/ Emergency spillway hydrograph is contained below crest of emergency spillway

TABLE 3 - STRUCTURE DATA

FLOODWATER RETARDING STRUCTURES
Timber Creek Watershed, Kansas

ITEM	UNIT	STRUCTURE NUMBER		
		4	5	6
Drainage Area	Sq. Mi.	1.45	.88	1.12
Storage Capacity				
Sediment	Ac. Ft.	67	64	80
Floodwater	Ac. Ft.	291	176	226
Water Supply	Ac. Ft.			
Total	Ac. Ft.	358	240	306
Between High and Low Stages	Ac. Ft.	209	138	176
Surface Area				
Sediment Pool	Acres	12	12	10
Floodwater Pool	Acres	50	40	39
Water Supply Pool	Acres			
Volume of Fill	Cu. Yds.	60,263	40,672	54,696
Elevation Top of Dam	Feet	1,448.9	1,432.3	1,419.5
Maximum Height of Dam	Feet	28.4	25.0	31.5
Emergency Spillway				
Crest Elevation	Feet	1,443.9	1,427.3	1,414.5
Bottom Width	Feet	40	40	40
Type	--	Rock	Veg.	Veg.
Percent Chance of Use	--	4	4	4
Average Curve No. - Cond. II	--	80	80	80
Emergency Spillway Hydrograph				
Time of Concentration	Hrs.	1.00	0.75	1.00
Storm Rainfall (6 hours)	Inches	6.08	6.1	6.1
Storm Runoff	Inches	3.85	3.87	3.87
Velocity of Flow (Vc) 1/	Ft./Sec.	3/	3/	3/
Discharge Rate 1/	c.f.s.	3/	3/	3/
Maximum W. S. Elevation 1/	Feet	3/	3/	3/
Freeboard Hydrograph				
Storm Rainfall (6 hours)	Inches	8.68	8.7	8.7
Storm Runoff	Inches	6.26	6.28	6.28
Velocity of Flow (Vc) 1/	Ft./Sec.	6.2	5.2	5.9
Discharge Rate 1/	c.f.s.	300	180	256
Maximum W. S. Elevation 1/	Feet	1,446.4	1,429.2	1,416.8
Principal Spillway				
Capacity - Low Stage 2/	c.f.s.	14.5	8.8	11.2
Capacity - High Stage 2/	c.f.s.	36.3	22.0	28.0
Capacity Equivalents				
Sediment Volume				
Below Crest of Prin. Splwy.	Inches	.50	.78	.75
Above Crest of Prin. Splwy.	Inches	.37	.59	.59
Total	Inches	.87	1.37	1.34
Detention Volume	Inches	3.77	3.77	3.77
Spillway Storage	Inches	3.80	5.18	4.03
Class of Structure	--	a	a	a

1/ Maximum during passage of hydrograph
2/ These are average capacities based on 0.8 times the peak capacity with the maximum head at the crest of the next stage
3/ Emergency spillway hydrograph is contained below crest of emergency spillway

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TABLE 3 - CONTINUED

STRUCTURE NUMBER						
7	8	9	10	11	12	13
1.58	1.74	1.09	1.48	2.02	.94	1.57
81	93	68	107	167	78	95
309	350	213	360	490	184	373
390	443	281	467	657	262	468
225	259	161	234	327	148	231
13	14	11	15	22	10	14
47	55	35	52	78	29	52
53,175	52,301	57,355	66,255	79,647	39,383	72,378
1,416.8	1,394.4	1,370.6	1,404.3	1,410.5	1,387.5	1,351.4
28.6	28.4	28.6	31.7	32.6	30.0	34.0
1,411.8	1,389.4	1,365.6	1,399.1	1,405.5	1,382.5	1,346.4
45	40	40	60	40	40	60
Rock	Rock	Veg.	Rock	Rock	Rock	Veg.
4	4	4	2	2	4	2
79	80	79	80	80	79	79
1.00	1.25	1.00	1.00	1.25	.75	1.00
6.07	6.08	6.04	8.68	8.68	6.05	8.68
3.74	3.85	3.71	6.26	6.26	3.72	6.14
3/	3/	3/	5.0	5.0	3/	5.2
3/	3/	3/	240	160	3/	270
3/	3/	3/	1,400.9	1,407.3	3/	1,348.3
8.68	8.68	8.68	14.67	14.67	8.68	14.68
6.14	6.26	6.14	12.05	12.05	6.14	11.91
6.7	8.7	6.7	9.6	8.0	6.2	9.4
414	344	368	1,644	916	300	1,536
1,414.6	1,392.1	1,368.4	1,404.3	1,410.2	1,385.0	1,351.4
15.8	17.4	10.9	14.8	20.2	9.4	15.7
39.5	43.5	27.3	37.0	50.5	23.5	39.3
.54	.56	.65	.75	.86	.86	.63
.43	.44	.52	.60	.69	.69	.50
.97	1.00	1.17	1.35	1.55	1.55	1.13
3.67	3.77	3.67	4.55	4.55	3.67	4.45
3.08	3.50	2.35	3.45	4.45	2.60	3.55
a	a	a	b	b	a	b

TABLE 3 - STRUCTURE DATA

FLOODWATER RETARDING STRUCTURES
Timber Creek Watershed, Kansas

ITEM	UNIT	STRUCTURE NUMBER		
		14	15	16
Drainage Area	Sq. Mi.	1.56	1.46	1.29
Storage Capacity				
Sediment	Ac. Ft.	70	93	63
Floodwater	Ac. Ft.	370	346	253
Water Supply	Ac. Ft.			
Total	Ac. Ft.	440	439	316
Between High and Low Stages	Ac. Ft.	220	219	183
Surface Area				
Sediment Pool	Acres	11	14	10
Floodwater Pool	Acres	50	49	37
Water Supply Pool	Acres			
Volume of Fill	Cu. Yds.	59,436	78,018	52,791
Elevation Top of Dam	Feet	1,367.6	1,333.3	1,333.6
Maximum Height of Dam	Feet	33.9	33.3	30.0
Emergency Spillway				
Crest Elevation	Feet	1,360.9	1,328.3	1,327.3
Bottom Width	Feet	40	50	40
Type	--	Rock	Rock	Rock
Percent Chance of Use	--	2	2	4
Average Curve No. - Cond. II	--	79	79	79
Emergency Spillway Hydrograph				
Time of Concentration	Hrs.	1.00	1.00	1.00
Storm Rainfall (6 hours)	Inches	8.9	8.7	6.08
Storm Runoff	Inches	6.16	6.16	3.75
Velocity of Flow (Vc) 1/	Ft./Sec.	6.9	5.0	3/
Discharge Rate 1/	c.f.s.	416	200	3/
Maximum W. S. Elevation 1/	Feet	1,363.9	1,330.1	3/
Freeboard Hydrograph				
Storm Rainfall (6 hours)	Inches	14.66	14.66	14.68
Storm Runoff	Inches	11.89	11.89	11.91
Velocity of Flow (Vc) 1/	Ft./Sec.	11.0	9.4	10.7
Discharge Rate 1/	c.f.s.	1,640	1,024	1,516
Maximum W. S. Elevation 1/	Feet	1,367.6	1,333.3	1,333.6
Principal Spillway				
Capacity - Low Stage 2/	c.f.s.	15.6	14.6	12.9
Capacity - High Stage 2/	c.f.s.	39.0	36.5	32.3
Capacity Equivalents				
Sediment Volume				
Below Crest of Prin. Splwy.	Inches	.44	.63	.51
Above Crest of Prin. Splwy.	Inches	.40	.56	.41
Total	Inches	.84	1.19	.92
Detention Volume	Inches	4.45	4.45	3.67
Spillway Storage	Inches	3.45	3.85	3.50
Class of Structure	--	b	b	a

1/ Maximum during passage of hydrograph
2/ These are average capacities based on 0.8 times the peak capacity with the maximum head at the crest of the next stage
3/ Emergency spillway hydrograph is contained below crest of emergency spillway

TABLE 3 - CONTINUED

STRUCTURE NUMBER						
17	18	19	20	21	22	23
1.35	2.27	3.48	4.80	6.96	2.40	.76
85	141	165	228	322	161	55
264	456	844	1,203	1,744	499	158
349	597	1,009	1,431	2,066	660	213
199	346	490	727	1,045	384	123
11	15	31	31	37	24	10
37	59	137	178	216	94	44
62,082	73,838	139,413	122,039	157,796	68,420	43,346
1,328.6	1,319.6	1,403.9	1,398.3	1,327.2	1,302.5	1,310.1
37.0	37.8	29.9	36.3	41.2	27.0	23.1
1,322.6	1,313.5	1,397.9	1,391.3	1,320.0	1,297.5	1,305.1
40	80	52	40	100	40	40
Rock	Rock	Rock	Rock	Rock	Rock	Rock
4	4	2	2	2	4	4
79	80	80	81	81	81	81
1.00	1.25	1.75	2.25	3.25	1.50	0.75
6.02	6.04	8.70	8.70	8.63	6.02	6.02
3.70	3.81	6.28	6.39	6.32	3.90	3.90
3/	3/	4.0	5.7	5.6	3/	3/
3/	3/	245	236	540	3/	3/
3/	3/	1,399.9	1,393.5	1,322.1	3/	3/
14.68	14.68	14.68	14.66	14.65	8.63	8.63
11.91	12.06	12.07	12.17	12.16	6.32	6.32
10.5	10.5	5.8	11.3	11.4	5.4	4.9
1,435	2,880	1,820	1,808	4,720	196	144
1,328.6	1,319.6	1,403.9	1,398.3	1,327.2	1,299.5	1,306.8
13.5	22.7	34.8	48.0	69.6	24.0	7.6
33.8	56.8	87.0	120.0	174.0	60.0	19.0
.66	.65	.60	.50	.50	.70	.76
.52	.52	.29	.39	.37	.56	.60
1.18	1.17	.89	.89	.87	1.26	1.36
3.67	3.77	4.55	4.70	4.70	3.90	3.90
3.83	3.13	5.00	5.50	4.20	5.10	6.60
a	a	b	b	b	a	a

TABLE 3 - STRUCTURE DATA

FLOODWATER RETARDING STRUCTURES
Timber Creek Watershed, Kansas

ITEM	UNIT	STRUCTURE NUMBER		
		24	25	26
Drainage Area	Sq. Mi.	.99	1.40	3.19
Storage Capacity				
Sediment	Ac. Ft.	79	91	177
Floodwater	Ac. Ft.	206	350	662
Water Supply	Ac. Ft.			
Total	Ac. Ft.	285	441	839
Between High and Low Stages	Ac. Ft.	164	222	496
Surface Area				
Sediment Pool	Acres	14	12	22
Floodwater Pool	Acres	46	67	92
Water Supply Pool	Acres			
Volume of Fill	Cu. Yds.	44,163	54,438	87,891
Elevation Top of Dam	Feet	1,293.0	1,283.4	1,255.6
Maximum Height of Dam	Feet	22.0	29.4	34.6
Emergency Spillway				
Crest Elevation	Feet	1,288.0	1,278.4	1,249.6
Bottom Width	Feet	40	40	40
Type	--	Rock	Rock	Rock
Percent Chance of Use	--	4	2	4
Average Curve No. - Cond. II	--	81	81	81
Emergency Spillway Hydrograph				
Time of Concentration	Hrs.	0.75	1.00	1.75
Storm Rainfall (6 hours)	Inches	6.02	8.63	6.03
Storm Runoff	Inches	3.90	6.32	3.90
Velocity of Flow (Vc) 1/	Ft./Sec.	3/	4.5	3/
Discharge Rate 1/	c.f.s.	3/	112	3/
Maximum W. S. Elevation 1/	Feet	3/	1,279.9	3/
Freeboard Hydrograph				
Storm Rainfall (6 hours)	Inches	8.63	14.66	8.65
Storm Runoff	Inches	6.32	12.17	6.34
Velocity of Flow (Vc) 1/	Ft./Sec.	5.9	8.2	7.2
Discharge Rate 1/	c.f.s.	256	684	464
Maximum W. S. Elevation 1/	Feet	1,290.3	1,282.4	1,252.8
Principal Spillway				
Capacity - Low Stage 2/	c.f.s.	9.9	14.0	31.9
Capacity - High Stage 2/	c.f.s.	24.8	35.0	80.0
Capacity Equivalents				
Sediment Volume				
Below Crest of Prin. Splwy.	Inches	.83	.68	.57
Above Crest of Prin. Splwy.	Inches	.67	.55	.47
Total	Inches	1.50	1.23	1.04
Detention Volume	Inches	3.90	4.70	3.90
Spillway Storage	Inches	5.30	5.00	3.00
Class of Structure	--	a	b	a

1/ Maximum during passage of hydrograph
2/ These are average capacities based on 0.8 times the peak capacity with the maximum head at the crest of the next stage
3/ Emergency spillway hydrograph is contained below crest of emergency spillway

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TABLE 3 - CONTINUED

STRUCTURE NUMBER						
27	28	30	31	32	33	34
.98	1.41	2.69	1.94	.95	.81	1.76
65	94	187	134	81	52	113
204	294	574	414	203	173	375
269	388	761	548	284	225	488
157	227	450	324	165	133	290
10	11	17	10	13	9	16
37	41	64	45	51	35	73
48,316	75,431	92,721	90,089	50,280	48,957	79,766
1,241.9	1,228.2	1,206.6	1,222.7	1,286.0	1,303.6	1,293.0
26.9	35.0	41.6	45.7	25.0	25.6	28.0
1,236.9	1,223.2	1,201.4	1,217.7	1,281.0	1,298.6	1,288.0
40	40	80	90	40	40	40
Rock	Rock	Rock	Rock	Rock	Rock	Rock
4	4	4	4	4	4	4
81	81	82	82	82	82	82
0.75	1.00	1.50	1.25	0.75	0.75	1.25
6.02	6.02	6.05	6.05	6.04	6.05	6.05
3.90	3.90	4.03	4.03	4.01	4.03	4.04
3/	3/	3/	3/	3/	3/	3/
3/	3/	3/	3/	3/	3/	3/
3/	3/	3/	3/	3/	3/	3/
8.63	8.63	8.69	8.69	8.68	8.66	8.66
6.32	6.32	6.52	6.52	6.51	6.49	6.49
5.6	6.4	6.8	6.5	5.6	5.4	6.2
216	320	784	774	216	196	300
1,239.0	1,225.8	1,204.3	1,221.1	1,283.0	1,300.6	1,290.5
9.8	14.1	26.9	19.4	9.5	8.1	17.6
24.5	35.3	67.3	48.5	23.8	20.3	44.0
.69	.69	.72	.72	.88	.67	.66
.55	.55	.58	.58	.72	.53	.54
1.24	1.24	1.30	1.30	1.60	1.20	1.20
3.90	3.90	4.00	4.00	4.00	4.00	4.00
4.65	3.30	2.65	2.00	4.25	5.08	4.45
a	a	a	a	a	a	a

TABLE 3 - STRUCTURE DATA

FLOODWATER RETARDING STRUCTURES
Timber Creek Watershed, Kansas

ITEM	UNIT	STRUCTURE NUMBER 35	STRUCTURE NUMBER 29	TOTAL
Drainage Area	Sq. Mi.	1.20	34.94 4/	99.92
Storage Capacity				
Sediment	Ac. Ft.	77	1,925	5,757
Floodwater	Ac. Ft.	256	5,000	19,324
Water Supply	Ac. Ft.		18,075	18,075
Total	Ac. Ft.	333	25,000	43,156
Between High and Low Stages	Ac. Ft	199		9,984
Surface Area				
Sediment Pool	Acres	14	190	541 5/
Floodwater Pool	Acres	50	1,310	3,529
Water Supply Pool	Acres		1,120	1,120
Volume of Fill	Cu. Yds.	62,009	1,096,349	3,497,214
Elevation Top of Dam	Feet	1,305.0	1,275.0	xxxx
Maximum Height of Dam	Feet	26.4	74.0	xxxx
Emergency Spillway				
Crest Elevation	Feet	1,300.0	1,260.0	xxxx
Bottom Width	Feet	40	300	xxxx
Type	--	Veg.	Rock	xxxx
Percent Chance of Use	--	4	4	xxxx
Average Curve No. - Cond. II	--	82	80	xxxx
Emergency Spillway Hydrograph				
Time of Concentration	Hrs.	1.00	12.0 6/	xxxx
Storm Rainfall (6 hours)	Inches	6.05	12.0 6/	xxxx
Storm Runoff	Inches	4.04	8.8	xxxx
Velocity of Flow (Vc) 1/	Ft./Sec.	3/	8.9	xxxx
Discharge Rate 1/	c.f.s.	3/	6,600	xxxx
Maximum W. S. Elevation 1/	Feet	3/	1,265.3	xxxx
Freeboard Hydrograph				
Storm Rainfall (6 hours)	Inches	8.66	28.5 6/	xxxx
Storm Runoff	Inches	6.49	25.5	xxxx
Velocity of Flow (Vc) 1/	Ft./Sec.	5.9	17.0	xxxx
Discharge Rate 1/	c.f.s.	256	50,944	xxxx
Maximum W. S. Elevation 1/	Feet	1,302.3	1,275.0	xxxx
Principal Spillway				
Capacity - Low Stage 2/	c.f.s.	12.0	2,210 7/	xxxx
Capacity - High Stage 2/	c.f.s.	30.0		xxxx
Capacity Equivalents				
Sediment Volume				
Below Crest of Prin. Splwy.	Inches	.64	1.01	xxxx
Above Crest of Prin. Splwy.	Inches	.56	0.02	xxxx
Total	Inches	1.20	1.03	xxxx
Detention Volume	Inches	4.00	2.68	xxxx
Spillway Storage	Inches	3.05	10.31	xxxx
Class of Structure	--	a	c	xxxx

1/ Maximum during passage of hydrograph
2/ These are average capacities based on 0.8 times the peak capacity with the maximum head at the crest of the next stage
3/ Emergency spillway hydrograph is contained below crest of emergency spillway
4/ An additional 29.26 square miles is controlled above this structure by structures numbered 1-18
5/ Does not contain area of multi-purpose structure
6/ Storm duration 12 hours
7/ Capacity with water surface at Elevation 1260.0

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TABLE 4 - ANNUAL COSTS

Timber Creek Watershed, Kansas

(Dollars)

Evaluation Unit	Amortization of Installation Cost 1/	Operation, Maintenance and Replacement Costs 2/	Total
Floodwater Retarding Structures 1 through 28 and 30 through 35 and Multiple-Purpose Structure No. 29	158,400	22,100 3/	180,500

1/ Installation costs are based on 1963 prices. Installation costs are amortized over 100 years at 3 1/8 percent interest.

2/ Long term projected prices

3/ Includes $6,400 operation and maintenance and $5,100 replacement costs for basic recreation facilities.

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TABLE 5 - ESTIMATED AVERAGE ANNUAL FLOOD DAMAGE REDUCTION BENEFITS

Timber Creek Watershed, Kansas

(Dollars)[1/]

Item	Estimated Average Annual Damage		Damage Reduction Benefits
	Without Project	With Project	
Floodwater			
Crop and Pasture	123,000	34,800	88,200
Other Agricultural	25,200	7,700	17,500
Non-Agricultural			
Road and Bridge	34,300	9,100	25,200
Railroad	1,700	--	1,700
Subtotal	184,200	51,600	132,600
Erosion			
Flood Plain Scour	11,900	5,700	6,200
Indirect	20,700	6,100	14,600
Total - On Project	216,800	63,400	153,400

1/ Price base - long term projected prices

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TABLE 6 - COMPARISON OF BENEFITS AND COSTS FOR STRUCTURAL MEASURES

Timber Creek Watershed, Kansas

(Dollars)

Evaluation Unit	AVERAGE ANNUAL BENEFITS[1]							Total	Average Annual Costs[2]	Benefit Cost Ratio
	Flood Prevention				Secondary	Municipal Water	Recreation			
	Damage Reduction	More Intensive Use	Changed Land Use	Benefits Outside Watershed						
Floodwater Retarding Structures 1 through 28 and 30 through 35 and Multiple-Purpose Structure No. 29	140,900[3]	12,000	10,400	38,800	21,800	43,800	146,200	413,900	180,500	2.3:1
GRAND TOTAL	140,900	12,000	10,400	38,800	21,800	43,800	146,200	413,900	180,500	2.3:1

1/ Price base - long term projected prices
2/ Cost from table 4
3/ In addition, it is estimated that land treatment measures will provide flood damage reduction benefits of $12,500 annually

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INVESTIGATION AND ANALYSIS

COOPERATION IN PLANNING

Some engineering phases of watershed planning were accomplished with funds provided by the State of Kansas. These funds supplied the needed services through engineering contract between the Soil Conservation Service and two Kansas engineering firms.

Services rendered under a contract with Van Doren, Hazard, Stallings, and Schnacke, Engineers, Topeka, Kansas, were vertical control bench marks and hydraulic investigations.

A contract with Wilson and Company, Engineers, Salina, Kansas, provided topographic maps of reservoirs, spillways, and dam sites, stage-storage curves, and centerline profiles of the structure sites.

All other engineering phases and services were accomplished by the Soil Conservation Service Watershed Work Plan Staff and Work Unit Personnel.

PROJECT FORMULATION

The formulation of the structural system of this plan was accomplished jointly by the Soil Conservation Service and the Watershed District. The probable unit benefit per square mile for reservoirs in each subarea was developed and was graphically presented. These benefits were developed by evaluating a complete range of possible control by structures. All possible structures were located which were physically feasible and had a chance of economic justification. Costs were estimated for approximately 50 structures in this study. From this information 38 structures were selected for further study. Based on topographic and geologic surveys, 3 of these structures were eliminated due to economic and physical limitations. A system of 35 structures survived for the final plan.

ENGINEERING

Surveys

Vertical control lines were run throughout the watershed with permanent bench marks established within 1/2 mile of each structure site and each valley cross section. 209 permanent bench marks were set in the watershed. All surveys were referenced to mean sea level.

One hundred fifty seven valley cross sections were surveyed by Kelsh plotter. Sufficient readings were made to define the topography along each section; to locate all crop boundaries and changes in roughness factor; to locate all roads, fences, and other objects along the sections; and to define the shape of the channel in detail.

Structure drainage areas were stereoscopically delineated on low level aerial photographs and measured with a planimeter.

Topographic maps of 38 structure sites were made by use of a Kelsh plotter. The maps made by the Kelsh plotter were developed from aerial photographs with a scale of 1 inch equals 815 feet. A maximum contour interval of 4 feet was used. Storage capacities were measured from the topography maps and stage-storage curves developed. Embankment quantities were calculated from centerline profiles which were surveyed on 38 sites by use of a Kelsh plotter. Accuracy of the Kelsh work was verified by checking approximately 10 percent of the centerline profiles by field surveying.

Structure Design and Cost Estimates

The 34 floodwater retarding structures are planned with two-stage principal spillways. These provided an economical design and kept the outflow at desirable levels. The multi-purpose structure is planned with a single stage principal spillway. The crest of the first stage was planned at the elevation that provided the necessary sediment storage capacity in the reservoir. The second stage inlet was planned at the elevation that provided a 5-year detention storage. The crest of the emergency spillway was planned to provide at least a 25-year detention storage above the principal spillway invert. The free-board hydrograph was routed through all structures with the maximum elevation equal to or less than the elevation of the top of the dam. A minimum emergency spillway size of five feet deep by forty feet wide was used.

All structure drainage areas were stereoscopically delineated on aerial photographs. These were measured with a planimeter.

Structural data for each site is shown in table 3.

A cost estimate was calculated for each structure. Quantities of each item were based on surveyed data. Unit costs reflecting current bid prices for embankment, principal spillways, riprap, fencing, drain pipes, seeding, clearing, etc. were used to arrive at the total construction cost of each structure. Contingencies were calculated at 12 percent of the engineer's estimate. Installation services costs were calculated as a percent of construction costs.

Easements and rights-of-way costs were calculated for each site using unit values for cropland and pastureland agreed on by the sponsors.

Individual structure costs data is tabulated in table 2 and the total cost of all proposed structures is shown in table 1.

HYDROLOGY AND HYDRAULICS

The watershed was divided into 18 subwatershed areas. Evaluation reaches were selected to coincide with the subwatershed area limits. For location see project map.

Hydrologic soil-cover complex numbers were developed for each subwatershed area for present and future watershed conditions. Future watershed conditions are considered to exist when the land treatment and cover measures outlined in this plan are in effect.

Rainfall frequency was obtained from United States Weather Bureau Technical Paper Number 40.

To obtain the relation of rainfall to runoff, the procedure as outlined in Chapter 3.10 National Engineering Handbook, Section 4, Hydrology, Supplement A, was followed. A factor of 4 was used for conversion of annual flood plotting positions to partial duration plotting positions. The frequency versus volume runoff relationship was developed for the needed range of hydrologic soil-cover complex numbers.

The relationship between discharge and area of inundation was based on 157 valley and channel cross sections. These cross sections were all related vertically to mean sea level datum. They were horizontally related by being located on aerial photographs. The width flooded at the cross section and the distance between cross sections entered into computation of area flooded.

The IBM 650 electronic computer was used to make calculations for the hydraulics of the flood plain. A range of discharges was considered from below non-damage flow to above the 100-year frequency. The output from the computer gave elevation and area of inundation by depth increments for every discharge computed at each cross section.

Plan-profile sheets were prepared for the entire flood plain. Profiles were plotted showing the channel bottom, bank line, and at least four discharges. The plan map is a half-tone aerial photo of the flood plain projected onto the plan-profile sheets.

The relationship of discharge to area of inundation by depth increments was developed for each reach by combining data for all cross sections within each reach.

The relation of unit volume runoff to discharge was developed by floodrouting using Wilson's method. Triangular hydrographs, representing the unit volume of runoff from each subwatershed, were developed by the composite method with storm distribution from U. S. Weather Bureau Technical Paper 40. Floodrouting determined the discharge for a unit volume of runoff for each evaluation reach. This determination was made

for present conditions, future land treatment conditions, future land treatment conditions with various percentages of each subwatershed controlled by floodwater retarding structures, and future land treatment conditions with the formulated structural system. This gave the discharge-volume runoff relations for each evaluation reach considering a 0 to maximum percent range of area controlled by reservoirs and with the structural system presented in this plan. Frequency discharge relationships were tabulated for each of the above conditions.

A determination was made of the frequency of two historical storms which occurred in the watershed in 1958 and 1961. This was accomplished by securing high water marks for these storms and plotting them on the water surface profiles. This made it possible to determine the discharge of the actual storm at each reach. The discharge-frequency curve and the above discharges determined the frequency of the two storms at each reach.

Floodwater retarding structure release rates were established considering downstream channel capacities. Two stage release rates are planned in all structures. Combined maximum release rates will not exceed channel capacity. Individual structure release rates are shown in table 3.

The floodwater detention storage volume was determined by procedures in SCS Technical Release Number 10, modified to include effect of a saturated soil condition on incremental rainfall after the first day's precipitation. Storms used in connection with this procedure were taken from Weather Bureau Technical Paper No. 40. The volume for flood storage up to the second stage was computed using 5-year frequency storms. The total volume for floodwater storage was computed using 25 or 50-year frequency storms depending on structure hazard class.

Dimensions of the emergency spillways of the floodwater retarding structures were determined by floodrouting the storms indicated in SCS Engineering Memorandum No. 27 by the method outlined in Lincoln E&WPU Memorandum No. 2. Emergency spillways will exceed minimum criteria as established by the State of Kansas.

The design storm options of Engineering Memorandum 43 were tested for the emergency spillway design of structure No. 29. Inflow hydrographs and the reservoir routings were made using the IBM 7090 program available through the Central Technical Unit.

GEOLOGIC INVESTIGATIONS

Sedimentation in Reservoirs

Sediment rates and volumes were determined from sedimentation surveys made on existing reservoirs in the area. The range survey method was used to determine the sediment volume accumulated in each reservoir. Equipment used included survey instruments, boat, cable and meter, spud bar, and sounding bell.

Delta deposits were measured at from five to ten percent of the total sediment volume.

The significant sediment production factors of soil type, slope of the land, land use, and type of erosion were mapped on the drainage area above each surveyed reservoir. Sediment rates were computed for each reservoir. Variations in the sediment rates were equated to the difference in the sediment producing factors of the drainage area.

Sediment rating curves were developed from the above computations. These curves show sediment yield in acre feet per square mile per year versus drainage area size. The curves were plotted for a range of sediment producing factors.

Sediment producing factors of the drainage areas above floodwater retarding structures were mapped and compiled. Sediment yield to each reservoir was read from the sediment rating curves. An additional 10 percent was added above the sediment pool for delta deposition on reservoirs having a drainage area in excess of two square miles.

In the multi-purpose structure the sediment distribution is 82 percent in sediment and recreation pools, 13 percent in the water supply pool, and 5 percent in the flood pool.

Flood Plain Scour

The extent and severity of sheet scour and channel scour resulting from floods was determined from field surveys. The 157 valley cross sections were used in this study. The scour areas were mapped on aerial photographs. The degree of damage was based on the loss of productivity as compared with the unaffected parts of the field. Information derived from interviews with work unit personnel, soil scientists, and farmers aided in assembling land damage information.

Sheet and channel erosion was tabulated in acres with the percent of damage in each of the evaluation reaches. Only eroded areas affected by upstream runoff were considered.

Future scour erosion in the next 100 years was estimated without the program for each reach. Future damage was based on soil type, present soil depth on the eroded areas, and the annual rate of erosion. The future damages were computed by:

> Present percent of damage divided by years of accelerated erosion times 100 years plus present percent of erosion is equal to percent of damage in 100 years (not to exceed 100 percent).

The recovery period for each reach in years was established from the amount of damage, the soil type, and the length and number of crop rotations required for potential recovery.

The potential recovery of soil productivity without floods depends primarily on the capability class of the soil and the present soil depth. Affected areas having soil with 60 inches or more in depth and in Class I and II are considered capable of full recovery. Other classes of land with less depth of soil were considered to recover partially as compared to original productiveness.

The percent of recovery for each evaluation reach at the end of the recovery period was determined by:

Present damage times percent of potential recovery times percent of area control is equal to percent of recovery.

Dam Sites

A geologic investigation was conducted at each proposed dam site. The work was accomplished by field observation, use of existing geologic maps, surveying instruments and hand and power augers. The report on each dam site includes a centerline profile showing geologic conditions. The borrow area is shown on the topographic map and a summary sheet attached.

Significant geologic features that might influence the design or construction of a structure were investigated. A limited number of test holes on the centerline determined the stability of the foundation. The amount of stripping and the depth of core trench were noted from the logs of the test holes.

The recommended location of the principal spillway was determined from the stability of the foundation, amount of excavation, length of conduit and the alignment of the pipe outlet to the stream channel. Quantities of materials to be excavated from the emergency spillway were estimated and their potential uses during construction were determined.

All soils investigated were classified by Unified Soil Classification.

Geologic Investigation Structure 29

Geologic maps of the area were studied to determine the extent and type of stratigraphy. The types of bedrock, the thickness of beds, their sequence, correlation and distribution were noted from the published geologic column of the area. Geologic bulletins were consulted to learn of geologic characteristics most likely to be found at the dam site.

A complete surface investigation of structural features was achieved prior to subsurface examination. Structure refers to all

characteristics having an influence on ultimate stability and safety. These features include the presence of faults and folds in the outcrops, textures and origin of the soil mantle and bedrock. Rock fractures, joints, unconformities, and weathered surfaces were examined as they relate to leakage. Materials to be used in the fill were visually surveyed as they affect stability and settlement of the embankment. The position of springs and their sources were noted.

Engineering surveys were conducted to map the outcropping beds in a three square mile area adjacent to the site. One survey was made along the base of the contact of the Ft. Riley and Florence formations. Another survey was run on the distinctive marly shale bed 15 feet above the base of the Ft. Riley. The elevations and direction of emergence of springs were mapped to assist in the correlation of the dip and porosity. The disposition of the beds furnished information on the possibility and extent of ground water recharge from the reservoir.

Seventy-three holes with a total footage of 1,163 feet were drilled in the foundation, spillway and borrow areas. Complete cores of the rock from the surface to 70 feet deep were cored at either end of the dam.

A descriptive log was shown for each hole. All static water elevations were recorded. Geologic cross sections were plotted on centerline, principal spillway, emergency spillway, and borrow area. A geologic column was assembled from the drill logs.

A pit was dug in each abutment to expose the vertical face of the Blue Springs shale. A search was made for cracks and fissures. The plasticity of the shale was checked. One pit was dug in the flood plain to expose the Kinney Limestone. The evidence of the weathered surface and high porosity required a recommendation for removal with the core excavation.

Air voids in the lower five feet of the Florence cores as well as springs emerging from this zone indicated a possible seepage zone. Four holes in each abutment were drilled to this zone for pressure testing to define the rate of permeability. Pressure of up to 50 pounds was applied at various depths with no water losses except in the lower five feet. The highest loss was 5 cubic feet per square foot of surface per day. This is not excessive when confined to a thin permeable section considering mantle thickness, length of travel, and fracture characteristics.

A grout curtain in the abutments was considered as a method to stop possible seepage losses. The method and costs of grouting of the Shawnee Lake dam near Topeka, Kansas, were used as a guide to decide when to grout and the extent and effectiveness of grouting.

Test holes drilled in the emergency spillway area to below spillway elevation disclosed the type of material and excavating method to be used to remove the limestone rock. Hardness tests indicated the desirability of the stone for slope riprap. The rate of erosion and depth of rock below the spillway floor was recorded.

The recommended location of the principal spillway was determined from the stability of the foundation, amount of footing excavation, the length of the conduit and the alignment of the pipe outlet to the stream channel. Test holes were bored to solid bedrock on the outlet pipe and riser locations. The type and amount of material to be excavated were shown.

The borrow area was tested at 200 feet grid intervals. Holes were bored through the alluvium to bedrock. Soil textures were grouped by the Unified Soil Classification System. The extent and depths of the borrow area needed for construction were shown on the topographic map. Depths to ground water were recorded.

Soil samples taken for each soil group were sent to the Soil Mechanics Laboratory, SCS, at Lincoln, Nebraska, for testing to determine the structural properties of the soils. Tests indicated that soils were satisfactory for use in the embankment. The foundation was stable.

The possibility of channel erosion below the structure caused from prolonged outflow from the reservoir was investigated. The amount and depth of fine material in the channel to be flushed were measured. Non-erosive bedrock strata was observed.

The Corps of Engineer's geologist was consulted at the Milford Reservoir near Junction City, Kansas. This structure is very similar in geologic location to structure No. 29 in Timber Creek. His recommendations proved useful in methods and procedures to follow in the investigations.

The Kansas Fish and Game Department dam (Rolla Clymer Reservoir) 20 miles to the northeast near Latham, Kansas, is located on identical geologic formation. The construction engineer was interviewed pertaining to methods of construction used at this site. A very successful dam was built with negligible seepage around or under the dam.

A special geologic report of the investigation with findings, recommendations and conclusions was written for the use of individuals and groups who may have a part in further planning and design.

ECONOMIC INVESTIGATIONS

The Frequency Method as described in Chapter 3 of the Economics Guide was followed in determining the average annual floodwater damages.

The watershed was divided into eighteen subwatersheds with evaluation reaches set to coincide with the subwatersheds.

Basic data necessary for the determination of damages were collected by personal contacts with farm operators, township and county officials, and with local agricultural technicians. Damage schedules were obtained from 40 to 80 percent of the landowners and operators of the flood plain area in each evaluation reach and the values expanded to 100 percent. The specific storms covered were May 1961 and a minor storm in July 1958. From rainfall records and high water marks, the frequency of these storms were determined for each evaluation reach. The damage schedules covered other agricultural damages such as losses of livestock, machinery, and stored grains; removal of debris; and damage to private roads, channel crossings, and fences.

Damages were computed by types in each of the evaluation reaches over the evaluation period for present land treatment conditions, future land treatment conditions, for a range of structure control up to a maximum, and with the formulated works of improvement in place. Benefits were computed for more intensive use and changed land use under these same conditions.

Floodwater damage to crops reflects the net loss in income for the 100-year storm series. It was computed by the determination of acres of cropland flooded and their depths of inundation. A composite acre of flood plain use was determined by interviews with farm operators and checked by field reconnaissance.

Average crop yields for the area, adjusted to flood-free conditions by judgment of farm operators and agricultural technicians familiar with the area, were used in the evaluation. A different composite acre and average yields were developed in a similar manner for use in determining the benefits attributable to more intensive use and changed land use. The composite acre of crops on the flood plain and their flood-free yields are as follows:

Crops	Percent Use	Flood-free Yield
Alfalfa	10	4 Ton
Corn	5	75 Bu.
Grain Sorghum	25	85 Bu.
Wheat	34	35 Bu.
Timber	10	--
Forage Sorghums	7	15 Ton
Tame Grasses	1	10 A.U.M.
Barley	8	40 Bu.

Crops	More Intensive Use Percent Use	Flood-free Yield
Alfalfa	10	4.5 Ton
Corn	5	78 Bu.
Grain Sorghum	25	88 Bu.
Wheat	34	40 Bu.
Timber	10	--
Forage Sorghums	7	17 Ton
Tame Grasses	1	10 A.U.M.
Barley	8	45 Bu.

The net value of the composite acre was weighted using lower values in the scoured areas. The damageable values by depth increments were adjusted to reflect the weighted values.

A percent loss from each crop was developed considering depth of inundation and month of flooding. The percent damage was used to determine damage for the composite acre. The rates of damage thus developed were weighted by the percent of the year's excessive storms that occur in each month and the weighted rate multiplied by acreages inundated by selected discharges. A dollar damage versus discharge curve was developed to provide a monetary value for each storm discharge in the 100-year storm series.

Road and bridge damages were based on information obtained from the county engineers office as to their repair or replacement costs. Road damages were computed as the dollar damage per foot by depth increments of inundation for the various types of road surfaces within the watershed. Bridge damages were estimated on individual bridges by various discharges. Road and bridge damages were then combined in each evaluation reach and dollar damage versus discharge curves were plotted. These curves were then applied to the 100-year storm series.

Indirect damages such as depreciation of property in the flooded areas, loss of time and additional expense of operators used in repair and clean-up which would normally be used in a productive operation, and additional distances driven by rural mail carriers, school busses, and farmers because of flooded roads, were considered. The indirect damages were computed as 10 percent of the crop and other agricultural damages and 15 percent of road, bridge, and railroad damage.

The estimate of damages to land through flood plain scour was derived from data gathered in the field by the geologist regarding acres damaged, severity of damage, and period and degree of recovery due to the installed program. The economic evaluation was based on the net value of the composite acre. The changes in net income due to scour damage were discounted at a 6 percent interest rate.

The off-project benefits assigned to the Timber Creek project are its fair share of the benefits accruing to the Soil Conservation Service watershed projects from the 9,680 acres of affected Walnut River flood plain. These benefits were jointly evaluated by the Kansas Board of Water Resources; Corps of Engineers, Tulsa District; and the Soil Conservation Service and are presented in the Survey Report on Walnut River, Kansas, 1963.

Municipal water supply benefits were determined by the city of Winfield and furnished to the watershed district for use in the work plan.

It was estimated that 468 acres of pastureland interspersed with brush and trees in localized areas adjacent to the streambanks will be cleared and used for crop production. This determination was supported by interviews with farmers, measurements of aerial photos, and from past experiences within the pilot watersheds. The farm owners and operators reported that where the topography allows, and where the expected frequency of damaging floods can be substantially reduced, that this change of land use will occur. Benefits from land use change were discounted for lag of accrual.

Secondary benefits were computed on two conditions using procedures outlined in Chapter 11 of the Economics Guide. One condition was the value of local secondary benefits stemming from the project. These values were determined as 10 percent of the direct primary project benefits. Indirect benefits were excluded from consideration in computing secondary benefits. The second condition was the value of local secondary benefits induced by the project. These values were determined as 10 percent of the increased costs that primary producers will incur in connection with increased production. These benefits were used in project justification and are included in the over-all B:C ratio of the program.

Recreational benefits were determined using methods outlined in Chapter 9 of the Economics Guide. The values used to measure the worth of a visitor day were taken from Supplement No. 1, Evaluation Standards for Primary Outdoor Recreation Benefits, Ad Hoc Water Resources Council, Washington D. C.

The cost of easements and rights-of-way were based on the value of cropland and pasture as determined by the Timber Creek Watershed Directors. These values, slightly higher than the capitalized value of net production, were used for project evaluation. The values agreed on were $105 per acre for upland and second bottom cropland, $200 for first bottom cropland and $80 per acre for pasture for the floodwater detention sites. Land costs of the sediment pool areas were based on 100 percent of its value, the structure and spillway areas on 75 percent, and the detention areas on 50 percent. The productive capacity retained under future conditions was thereby considered.

All monetary evaluations for benefits were based on long-term projected prices using "Agricultural Price and Cost Projections," Agricultural Research Service, dated September, 1957. Nineteen-sixty three construction costs as experienced in Kansas P.L. 566 projects under construction were used to estimate the construction costs of structural measures. Operation and maintenance costs were computed at 0.37 percent of construction cost for floodwater retarding structures. This factor also reflects long term projected price levels. This method of computing O & M costs (outlined by the Lincoln, Nebraska, Engineering and Watershed Planning Unit) is based on the principle that the relative probability of need for major type repairs decreases as the number of structures increases. Federal and local costs were amortized at 3 percent interest rate for a period of 100 years.

MULTIPLE-PURPOSE SITE NO. 29

Physical Data

Table A showing physical data for Site 29 follows this explanation on page 52.

Structure 29 has a planned capacity for 1,925 acre feet of sediment storage, 9,037 acre feet of recreation water storage, 9,038 acre feet of municipal water storage, and 5,000 acre feet of flood detention storage for a total of 25,000 acre feet. Of the 1,925 acre feet of sediment storage capacity, 1,160 acre feet is expected to accumulate below elevation 1223.5, 630 acre feet between elevation 1223.5 and elevation 1245.8 which is the portion reserved for recreation storage, 100 acre feet between elevation 1245.8 and elevation 1255.7 which is the portion reserved for municipal water supply, and 35 acre feet between elevation 1255.7 and the emergency spillway crest elevation which is that portion of the structure allocated to floodwater detention.

The total area of the permanent recreation pool is 710 acres. The incremental area of the municipal water supply pool is 410 acres. The total area of the flood pool at the crest of the emergency spillway (El. 1260.0) plus the area of the dam and spillway is 1,385 acres. The design storm of the emergency spillway floodrouted through the structure obtains an elevation of 1265.3 feet which is a flow depth of 5.3 feet. This surcharge covers an additional 335 acres for a total of 1,720 acres. It is considered that a minimum 100 feet horizontal strip of land from the emergency spillway crest elevation be acquired in fee title for a recreational development. Much of the terrain around the structure is very steep and the area required for the design storm does not extend 100 feet horizontally from the emergency spillway crest. To meet the 100 feet horizontal minimum an additional 89 acres will be necessary. To fully utilize the water and surrounding shore line for recreational purposes it

is necessary to have an additional area of 838 acres surrounding the dam and reservoir. To obtain access to the recreational development 31 acres of land was needed for access roads.

This brings the total area of land required for the development to 2,678 acres.

Cost Data

Costs of the dam and spillways and recreation facilities were supplied by the Soil Conservation Service. These were based on current prices experienced in the construction of like facilities.

Land, easements and rights-of-way costs were supplied by the city of Winfield.

Estimated costs are shown on table B following this discussion on page 53.

Cost Sharing

Cost sharing items and amounts are shown on table C following this discussion on page 54.

Reservoir costs for construction and installation services were allocated to flood prevention, municipal water, and recreation as to the percent of the volume of water each purpose had of the total volume in the reservoir. These computed to be flood prevention 24.7 percent, recreation 38.7 percent and municipal water 36.6 percent. In cost sharing these items the city of Winfield will pay all of the municipal water costs plus one half of the recreation construction costs. P.L. 566 will pay for all of the flood prevention costs plus all of the recreation installation services plus one half of the recreation construction costs.

The city of Winfield is to stand 100 percent of the local administration of contract costs.

Basic recreation facilities are cost shared 50 percent by the city and 50 percent by P.L. 566 funds.

Land, easements and rights-of-way costs for the multiple-purpose reservoir and associated recreation development are allocated to purpose in the following way. The reservoir requires rights on 1,809 acres of land. Flowage easements, to be obtained on 12 acres, at an estimated cost of $1,300 are allocated to flood prevention. Fee title will be acquired at an estimated cost of $405,500 for 1,797 acres, of which 410 acres or 22 percent is occupied by the incremental municipal water supply pool. Therefore,

22 percent of the fee area is allocated to municipal water and 78 percent to recreation. An additional 869 acres of land with an estimated value of $196,100 is allocated 100 percent to recreation. Road relocation and pipeline modification made necessary by the project is estimated to cost $254,000. This cost is allocated on the basis of area occupied by the incremental municipal water supply pool in relation to the total area, resulting in 16 percent allocated to municipal water supply and 84 percent to recreation.

Land, easements and rights-of-way costs are to be shared in the following way. The city of Winfield will pay for 100 percent of the cost of the 12 acres (estimated $1,300) of flowage easements. The city will also stand 100 percent of those costs allocated to municipal water. The city of Winfield, without Federal assistance, will buy 146 acres of the 869 acres of land to be acquired for recreation facilities and access roads. This area is shown on the multiple-purpose site map. The city of Winfield will stand 100 percent of all legal fees and survey costs in connection with land, easements, and rights-of-way. The city will cost share all remaining items allocated to recreation 50 percent. P.L. 566 will cost share 50 percent to all land, easements, and rights-of-way allocated to recreation with the exception of the above 146 acres.

TABLE A

Timber Creek Watershed

Multiple Purpose Site No. 29
(Floodwater Retarding, Municipal Water, and Recreation)

Physical Data Table

Item	Elevation	Storage Volume		Area	
		Acre Feet	Percent of Total	Acres	Accumulative Acres
Level Sediment Pool	1223.5	1,160	4.6	190	190
Recreation Pool[1/]	1245.8	9,667	38.7	520	710
Water Supply Pool[2/]	1255.7	9,138	36.6	410	1,120
Flood Pool[3/]	1260.0	5,035	20.1	190	1,310
Dam and Spillway				75	1,385
Flowage Pool (Emergency Spillway Hydrograph)	1265.3			335	1,720
Reservoir Access Area (That portion of the 100' horizontal strip above elevation 1265.3)				89	1,809
Access Roads				31	1,840
Additional Recreation Area				838	2,678
Total				2,678	2,678

1/ Contains 630 acre feet of sediment
2/ Contains 100 acre feet of sediment
3/ Contains 35 acre feet of sediment

TABLE B

Timber Creek Watershed
Multiple Purpose Site No. 29
(Floodwater Retarding, Municipal Water, and Recreation)

Cost Data Table

Item	Cost
Reservoir	
Construction	1,026,600
Installation Services	
Engineering	76,300
Other	17,000
Local Administration of Construction Contract	1,000
Recreation Facilities	
Construction	145,600
Engineering	14,600
Administration	3,000
Land, Easements, and Rights-of-Way	
Area for Water Reservoir (1,809 acres)	
Fee Title (1,797 acres)	405,500
Land Easements (12 acres)	1,300
Recreation Area (869 acres)	196,100
Road Relocation	235,000
Pipeline (modification)	19,000
Legal fees, survey costs, and other	31,700
Total Facility	2,172,700

TABLE C

Timber Creek Watershed

Multiple Purpose Site No. 29
(Floodwater Retarding, Municipal Water, and Recreation)

Cost Sharing Table

Item	P.L. 566 Cost	Other Cost	Total
Reservoir			
Construction	452,200	574,400	1,026,600
Installation Services			
Engineering	48,400	27,900	76,300
Other	10,700	6,300	17,000
Local Administration of Construction Contracts		1,000	1,000
Recreation Facilities			
Construction	72,800	72,800	145,600
Engineering	7,300	7,300	14,600
Administrative Costs	1,500	1,500	3,000
Land, Easements, & Rights-of-Way			
Area for Reservoir (1,809 acres)			
Fee Title (1,797 acres)	158,200	247,300	405,500
Flowage Easement (12 acres)		1,300	1,300
Recreation Area (869 acres)			
Cost-Shared Area (692 acres)	78,000	78,000	156,000
Access Road Area (31 acres)	3,600	3,600	7,200
Additional Area (146 acres)		32,900	32,900
Road Relocation	98,700	136,300	235,000
Pipeline Modification	8,000	11,000	19,000
Legal Fees, Survey Costs, and Other		31,700	31,700
Total	939,400	1,233,300	2,172,700

U. S. DEPARTMENT OF AGRICULTURE

SOIL CONSERVATION SERVICE

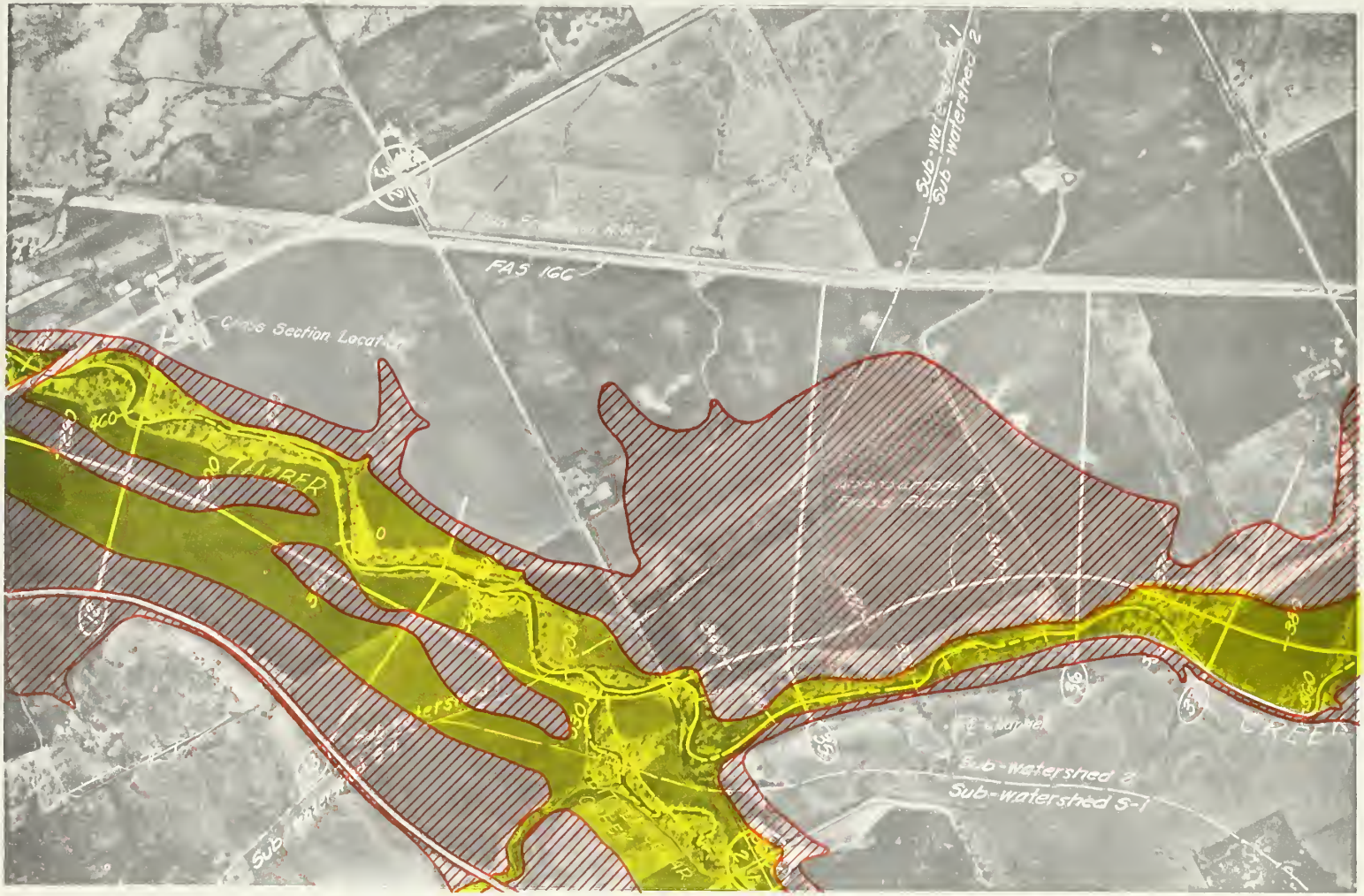
FIGURE 1

TIMBER CREEK WATERSHED-COWLEY & BUTLER COUNTIES KANSAS

AREA FLOODED WITH AND WITHOUT PROJECT

SEPTEMBER 1961 STORM

IN SUBWATERSHEDS 1 & 2

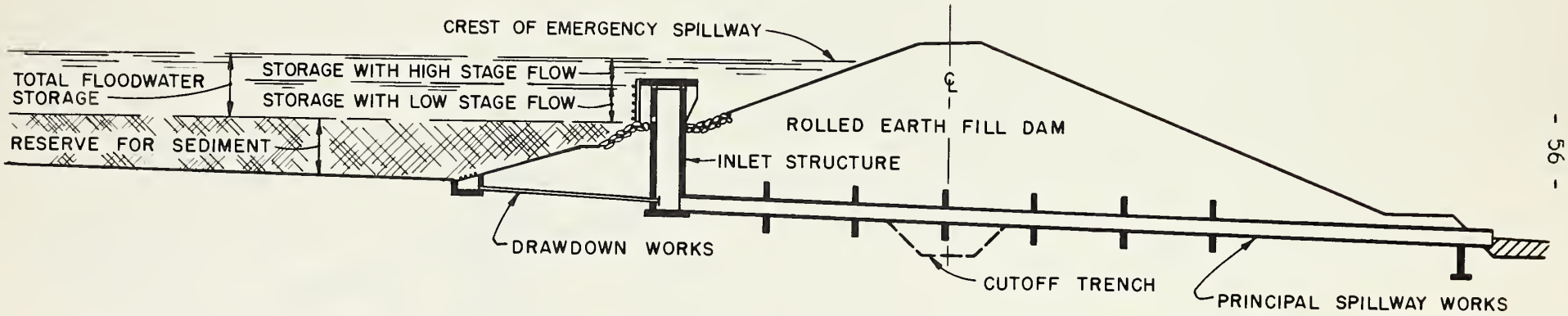


5, P-20,425

Figure 2

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

TYPICAL FLOODWATER RETARDING STRUCTURE WITH TWO-STAGE PRINCIPAL SPILLWAY



CROSS SECTION OF DAM ON ℄ OF PRINCIPAL SPILLWAY

NOTES:

1. LOW STAGE FLOWS TO BE REGULATED BY AN ORIFICE.
2. FOR INDIVIDUAL STRUCTURE DATA SEE TABLE 3.
3. EMBANKMENT AND FOUNDATION DESIGN FEATURES NOT SHOWN.

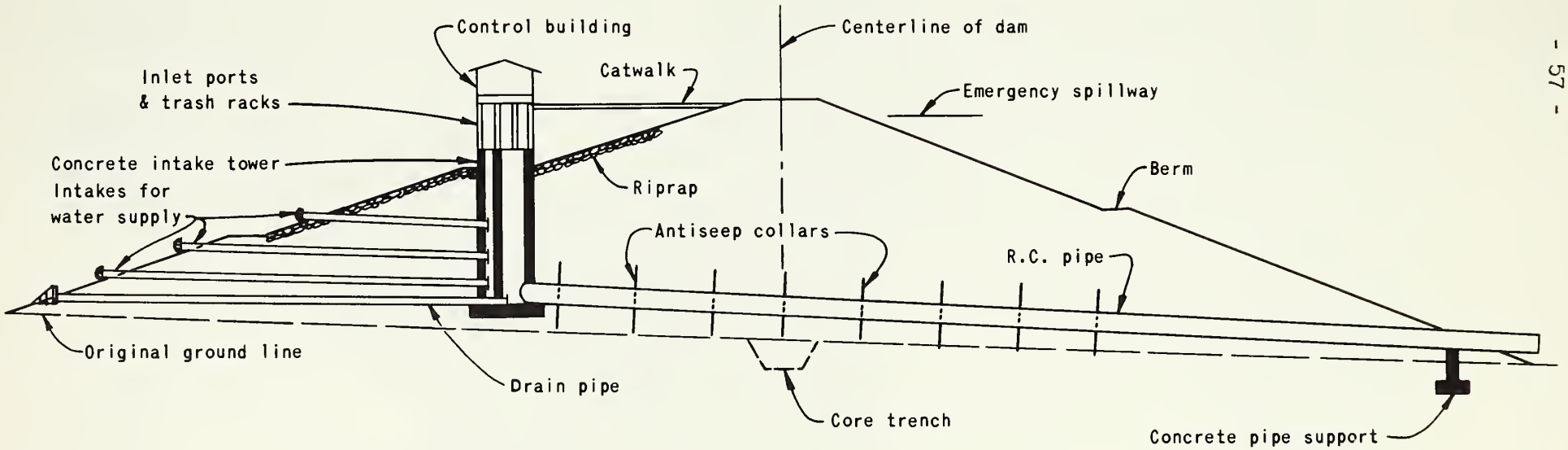
USDA-SCS LINCOLN NEBR 1964

5,L-20,378
7-64

Figure 3

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

TYPICAL MULTIPLE PURPOSE STRUCTURE



CROSS SECTION OF DAM ON CENTERLINE OF PRINCIPAL SPILLWAY

USDA-SCS-LINCOLN, NEBR. 1965

5,L-21,038

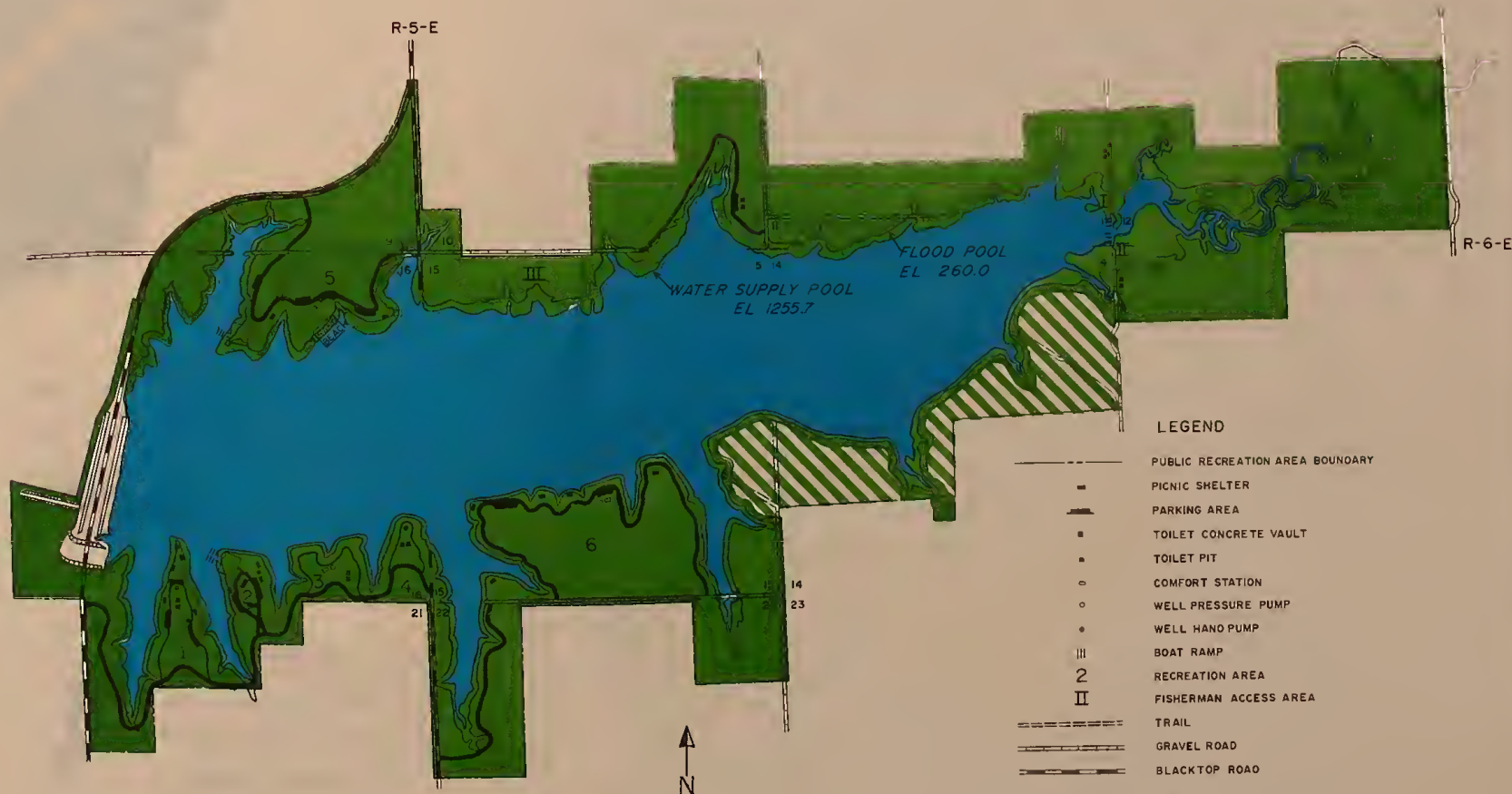
MULTIPLE PURPOSE DEVELOPMENT MAP

FLOODWATER RETARDING, MUNICIPAL WATER AND RECREATION

TIMBER CREEK WATERSHED

SITE NO. 29

COWLEY COUNTY, KANSAS



LEGEND

- PUBLIC RECREATION AREA BOUNDARY
- PICNIC SHELTER
- PARKING AREA
- TOILET CONCRETE VAULT
- TOILET PIT
- COMFORT STATION
- WELL PRESSURE PUMP
- WELL HAND PUMP
- BOAT RAMP
- 2 RECREATION AREA
- II FISHERMAN ACCESS AREA
- TRAIL
- GRAVEL ROAD
- BLACKTOP ROAD
- PROPOSED ACCESS ROADS
  - GRAVEL ONE WAY
  - GRAVEL TWO WAY
- WATER SUPPLY POOL
- PUBLIC RECREATION
- NONFEDERALLY ASSISTED RECREATION AREA

THIS PROJECT LOCATED BETWEEN:

LATITUDES	37°20' - 37°22'
LONGITUDES	96°49' - 96°54'

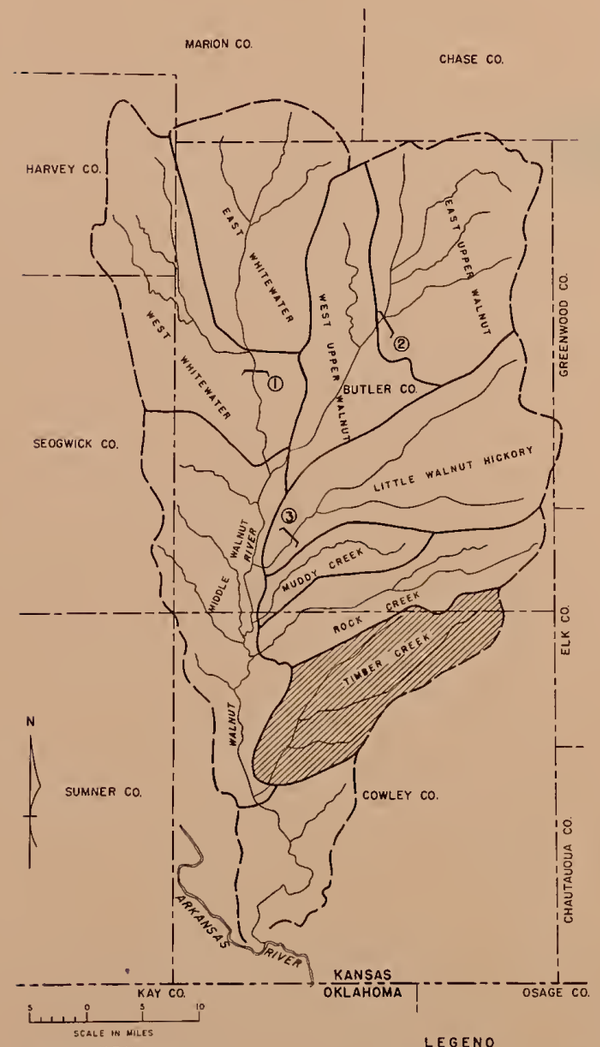
KANSAS

RECREATIONAL DEVELOPMENT

12-23-64

S.R-20,771

WATERSHED PROJECTS LOCATION
WALNUT RIVER BASIN



KEY

DAM SITES PROPOSED BY CORPS OF ENGINEERS

① TOWANDA RESERVOIR
② EL DORADO RESERVOIR
③ DOUGLASS RESERVOIR

LEGEND

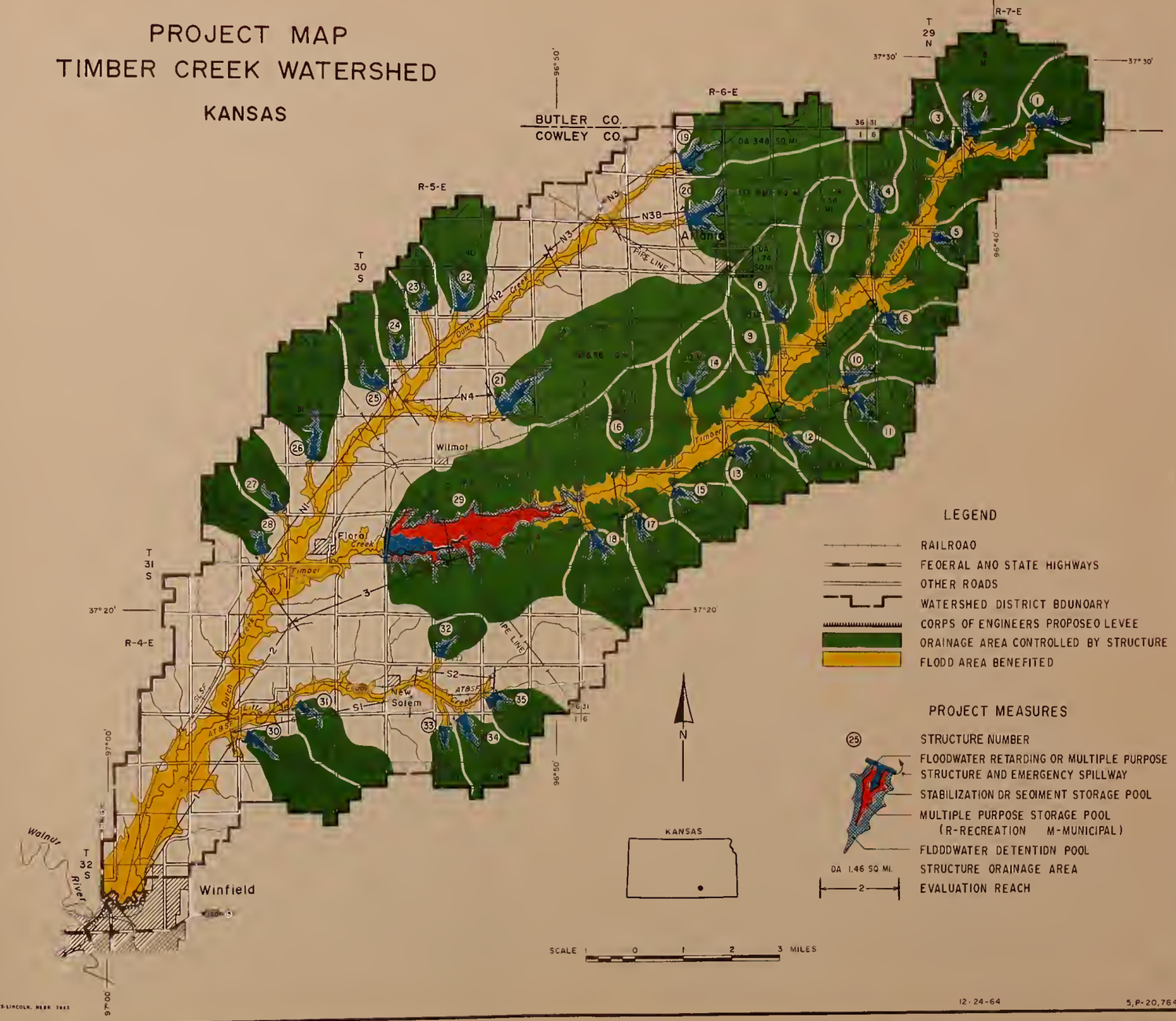
WALNUT RIVER WATERSHED BOUNDARY

PROJECT WATERSHED BOUNDARY

U. S. DEPARTMENT OF AGRICULTURE

SOIL CONSERVATION SERVICE

PROJECT MAP
TIMBER CREEK WATERSHED
KANSAS



LEGEND

- RAILROAD
- FEDERAL AND STATE HIGHWAYS
- OTHER ROADS
- WATERSHED DISTRICT BOUNDARY
- CORPS OF ENGINEERS PROPOSED LEVEE
- DRAINAGE AREA CONTROLLED BY STRUCTURE
- FLOOD AREA BENEFITED

PROJECT MEASURES

(25) STRUCTURE NUMBER

FLOODWATER RETARDING OR MULTIPLE PURPOSE STRUCTURE AND EMERGENCY SPILLWAY

STABILIZATION OR SEDIMENT STORAGE POOL

MULTIPLE PURPOSE STORAGE POOL (R-RECREATION M-MUNICIPAL)

FLOODWATER DETENTION POOL

DA 1.46 SQ MI. STRUCTURE DRAINAGE AREA

2 EVALUATION REACH

USDA SCS-LINCOLN, NEBR 1963

12-24-64

5,P-20,764